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THE NATIONAL EXPOSITION AT RIO DE JANEIRO

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A MONTH later than the date originally set for its opening, the first National Exposition of Brazil was officially inaugurated on August 11. Patriotic pride in the gratifying evidence which the exhibits give of Brazilian arts and industries, and of Brazilian progress, is the dominant note everywhere. As one of the leading newspapers of Rio has enthusiastically said:

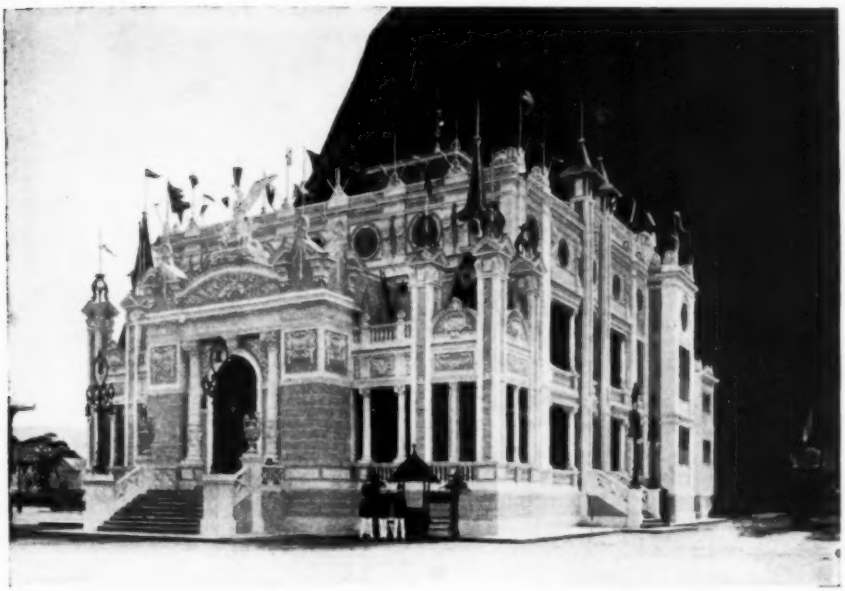
> The one feeling that every one has in his heart is an immense satisfaction, an overwhelming patriotic joy, as he sees this splendid exposition which gives evidence of our national capacity for work, and of our national vitality.

In his opening address, the president of the exposition commission referred to the important event in the history of Brazil which the exposition commemorates, viz., the opening of the Brazilian ports to the commerce of the world, one hundred years ago (January 28, 1808), and to the desire of the present government to bring together, on this centennial anniversary, the evidence of Brazilian progress in the last one hundred years. There have, it is true, been previous exhibitions, on a small scale, along similar lines. Thus, the Brazilian exhibits which were sent to London in 1862; to Vienna in 1873; to the Centennial in 1876; to Paris in 1889; to Chicago in 1893, and to St. Louis, were previously collected and open to the public in Rio. But the present exposition is far more representative and more complete than any of these others. Every one of the twenty states of Brazil is here represented, as well as the Federal District of Rio de Janeiro and the territory of Acre, "that precious piece of land recently added to our national demain," as one newspaper characteristically puts it, and goes on to say, "All the cells of our national organism here palpitate

PANORAMA OF A SECTION OF THE NATIONAL EXPOSITION GROUNDS.
In the foreground is the Botanical Garden Pavilion. To the left is that of the San Paulo, and to the right the Federal District Pavilions. The Textile Industries Building is in the background. This illustration and the other illustrations used in this article are printed here by the courtesy of the Editor of the *Bulletin* of the International Bureau of American Republics.

with life, showing the latent force which is impelling us on to the magnificent destiny prepared for our country by a Divine Providence."

The background, with Rio's wonderful hills, and the foreground, with Rio's magnificent bay, combine here to make a natural setting which it is safe to say no national or international exposition has ever had. No artificial lakes and canals, picturesque as these may be; no magnificent buildings; no marvels of electric lighting; no fountains or cascades—none of the things that have made other expositions famous, can compare with what nature herself has done in giving Rio de Janeiro this splendid harbor and these mountains, here green and soft, there grim and bare, with the famous "Sugar Loaf" guarding the



THE EXPOSITION THEATER.
The theater has a seating capacity of about 750.

entrance to the harbor on one side of the exposition grounds, and the precipitous Corcovado, towering up like a sentinel above the city, on the other. To readers who do not know Rio de Janeiro, the words of the opening address, in which the beauties of the city were enthusiastically described, will seem like undue exaggeration. The speaker said:

> The most beautiful city in South America, where the deep sea and the laughing bays; the high and solemn peaks; the gently-sloping hills; the rows of houses bathed in sunshine or showing, less distinctly, in the lights of the rosary of diamonds which surrounds the shores, fantastically mirrored in the waters of the bay—these combine to give a picture which is wholly unique in

the world—to strangers, a surprise and an enchantment; to us Brazilians a source of pride.

The visitor who comes to Rio with the idea that he is to see a grand exposition, on a large scale, will be disappointed. Compared with any of the international expositions, this Brazilian undertaking is naturally very small. It covers but little ground. Its buildings are few in number, and not notable for size, beauty of architecture, or originality of arrangement. The exhibits are not numerous, nor are they very impressive, to the casual visitor. But the Rio Exposition means very much to Brazilians. Seen with their eyes, it embodies the

THE PORTUGUESE PAVILION.
This pavilion was erected and offered by Brazil to the Portuguese nation for exhibition purposes.

spirit of their national progress; it gives tangible evidence of what Brazil can do in the way of products and manufactures; it serves to show that Brazil is becoming less dependent upon foreign countries; it therefore strongly appeals to the patriotic side of the people. When looked at by a foreigner so far as possible with Brazilian eyes, this exposition is not merely interesting; it is well worth careful study. The location was wisely chosen, at the southern end of the city, near the old military school, where the land now occupied by the exposition buildings was largely wasted. That quarter of the city will, from this time on, assume a different aspect. Most of the money which has been spent by the government has gone into permanent buildings. The

THE TEXTILE INDUSTRIES BUILDING.
This monumental structure, surmounted by a statue of Fame, is the remodeled Military Academy.

THE BANGŪ FACTORY BUILDING.
This building was erected by the Bangū Textile Mills for the exhibit of its products.

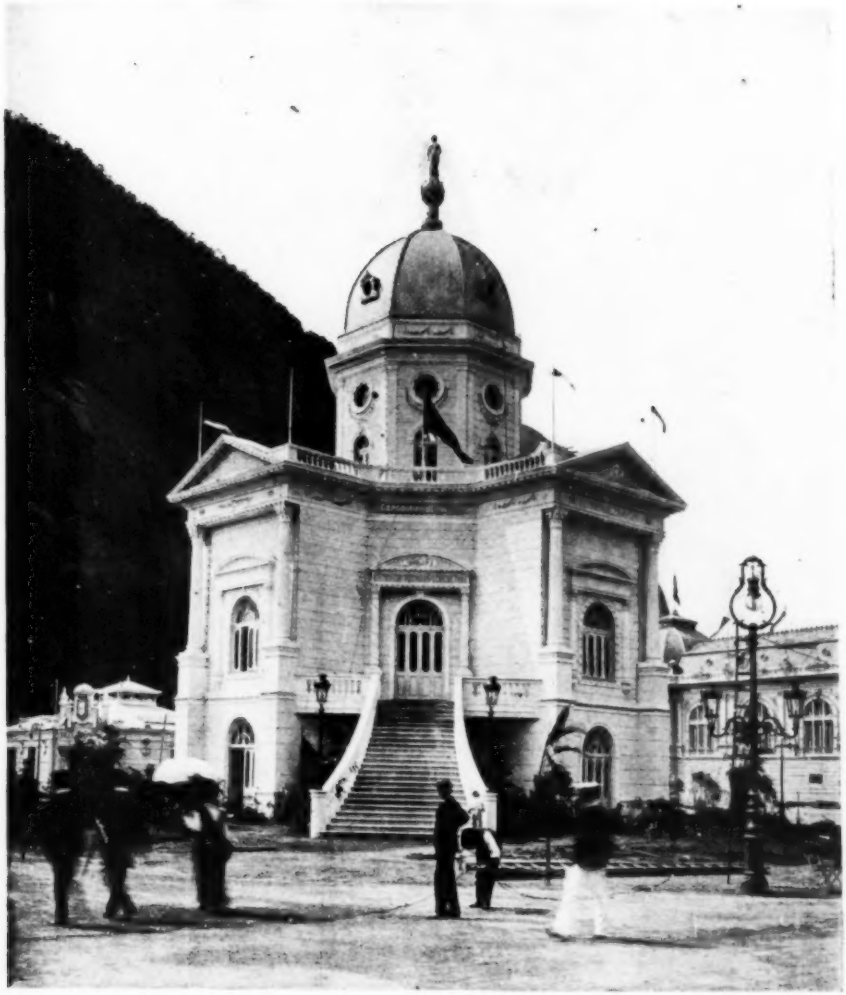
EXPOSITION PALACE.
The palace was used for official receptions during the exposition and for the exhibits of those states which had no special buildings. It was formerly the War University.

old military school building was largely torn down and then rebuilt, and one of the other buildings, which before was standing half-done and unused, has been completed and made into a fine permanent structure of stone. The land has been graded and cleared. A new sea-wall and boulevard have been built out to the exposition grounds. This is all clearly for the permanent advantage of the city, although the exposition itself, as a whole, will doubtless be a financial failure.

Brazil is an immense country. From the northern states with their vast forests—which most of us make the mistake of thinking cover the larger part of the country—to the southern states of Rio Grande do Sul and Santa Catharina, it includes climates of many kinds. The visitor to this exposition will see rubber and wheat; sugar-cane and corn; cotton, rice, manioc, coffee, maté, grapes, tobacco, alfalfa, sorghum. He will see most of the familiar vegetables and cereals of home, and next to them can examine the characteristic tropical woods from the forests of the Amazon. Amazonas and Para on the north have sent the products of the tropics; Minas Geraes has sent its famous cheeses, made from the milk of cows pastured on its great inland campos, as well as specimens of its gold and diamonds and precious minerals, and a fine model of its well-known Morro Velho mine. Santa Catharina on the south sends wheat and corn, wine, tobacco, cotton, coffee, dried beef, cheese, tinned butter, and the like—products of its temperate climate and of its cattle industry. It is probable that most Brazilians, as well as most foreigners, will be surprised at the variety of food-stuffs here exhibited, but it is certain that few visitors to this exposition will expect to see such evidence as is here given of the development of different industries in Brazil. Even the leading newspapers of Rio express surprise at the exhibits of cotton and woolen cloth; of footwear and of hats; of canned foods; of wines and beer; of dairy products, furniture, glassware, pottery and iron-work. The pride of Brazilians is especially appealed to by the exhibit of native foundry-work, of agricultural implements and of machinery of various kinds, for preparing rice, manioc, coffee and sugar-cane. By "special concession" on the part of the government, Germany and the United States have been permitted to exhibit machinery, some of it in operation. The former country shows agricultural implements and machinery for preparing rice, manioc, etc. From the United States there are exhibits by the United Shoe Machinery Co., the Continental Gin Co., of Birmingham, Ala., the Oliver Chilled Plow Co., of Indiana, and the Loomis Co., of Indiana. The Federal District (Rio de Janeiro) makes an effective showing with furniture and cabinet work, carriages and wagons, flour, glassware, laces, some excellent pottery and tiles, drugs and chemicals, bricks, wooden-ware, wire work, and a good collection of vegetables (fresh and dried) grown in the market

POST-OFFICE AND TELEGRAPH BUILDING.

gardens around the capital. Para, at the mouth of the Amazon, sends pottery and tiles; and an excellent exhibit from one firm in the city of Porto Alegre (State of Rio Grande do Sul) includes metal bedsteads and other articles of furniture, stoves, galvanized iron-work, safes, locks, etc., which would look well in any exposition anywhere. Those who have traveled in Germany will see unmistakable evidence of German skill and workmanship in the Santa Catharina exhibit of



AGRICULTURAL DEPARTMENT BUILDING.

needlework and embroidery, baskets, furniture and woodenware, and oil paintings, and a copy of "Der Urwaldsbote," published in Blumenau, shows that the language of the Fatherland is not forgotten in the midst of the new surroundings of Brazil.

Mere enumeration of the kinds of exhibits is tedious alike to writer and to reader; it leaves a confused impression on the mind. In any exposition, even a small one such as this in Rio, the best that can be done is to single out a few things for special mention. The exhibit made by the director of the Botanical Garden is representative, so far as it was possible to make it under the circumstances. In and around a glass pavilion there are shown, in pots, 1,337 selected plants, all care-

FEDERAL DISTRICT BUILDING.

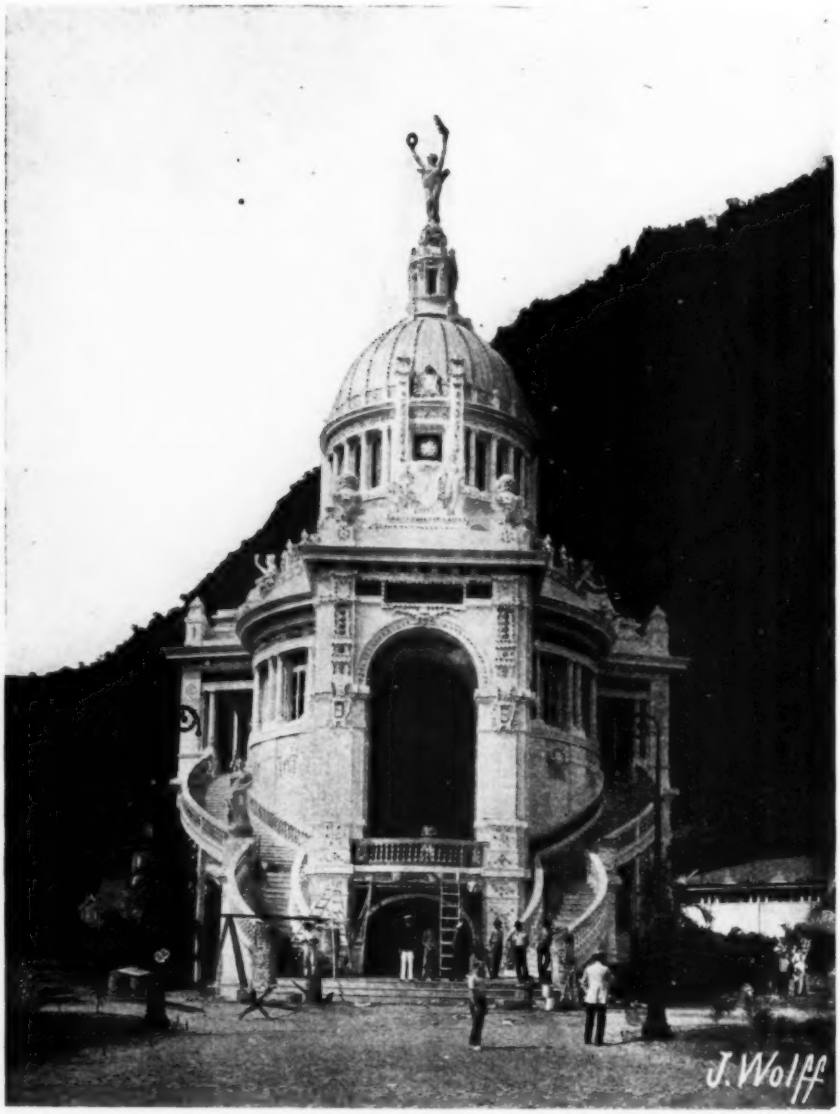
THE SAN PAULO PAVILION.

The San Paulo Building stands next to that of Minas Geraes, and covers an area of 4,593 square feet. It was one of the finest buildings of the exposition.

fully labeled and classified. These include 245 palms, 144 ferns, 112 fruits, and a large number of specimens of special economic and medicinal value, including dyewoods. The colors of the labels distinguish the different groups of plants. For example, dark green is for medicinal plants; white for cotton; red for the purely ornamental; yellow for fibrous; vermilion and white for dyewoods; vermilion for oil and resinous; etc. The opportunity here afforded, of a close examination, within a conveniently restricted area, of the characteristic plants of Brazil, is an excellent one. A collection of all the publications of the Botanical Garden is arranged inside the glass pavilion, and includes two volumes of the splendid work by Dr. Barbosa Rodrigues, the director of the garden, "Sertum Palmarum Brasiliensum." These volumes are placed on an inclined shelf, where they may be freely consulted by any visitor, and are not even fastened in any way to the shelf. The authorities must have abundant faith in the honesty of the public here. Or perhaps it may be the duty of some watchman—who was absent on the occasion of the writer's visit—to guard these books.

The Astronomical Observatory of Rio has put on exhibition a Wiechert seismograph, recently imported from Germany. This machine is of a somewhat simpler pattern than the Bosch-Omori seismograph, lately installed in the Geological Section of the Harvard University Museum, at Cambridge. It is very badly set up so far as detecting earthquake shocks is concerned, for it cannot fail to be affected by the movements of the people who are walking about on all sides of it, but the writer was given to understand that, for exhibition purposes, it was desired to have the public see, with its own eyes, how sensitive such a machine is, and from that point of view it is admirably exposed! The observatory exhibit also includes several large diagrams showing the variations in the different weather elements at Rio during the year. Here one may see the extraordinary preponderance of winds from southeast and from northwest; the slight changes in temperature throughout the year; the marked rainy season of summer; the higher pressure, clearer skies and drier air which characterize the winter. Another meteorological exhibit is that of the meteorological department of the Brazilian navy. This branch of the government has charge of the daily weather map and of the daily weather forecast, and has a small working meteorological station in the cupola of the building of the mail and telegraph service, where the work is explained and the forecasts are displayed.

The broadest generalization that one can give regarding the exhibits as a whole is that the southern states of Brazil are far ahead, industrially, of the central and especially of the northern states. This results naturally from the fact that the southern states have a far more extended railroad development and are—or rather because they



BAHIA BUILDING.

The Bahia Pavilion occupies an area of 54,359 square feet. The exterior is adorned with two majestic statues of Justice and Science, and a central group consisting of figures bearing a shield, representing the State of Bahia.

are—settled by a large number of recent European immigrants. The exhibit of Rio Grande do Sul, the southernmost Brazilian state, adjoining Uruguay, is a revelation to every one who sees it. The writer's guide through this exhibit was a typical representative of the state. With French and German blood in his veins, but himself a thorough

Brazilian, he took enthusiastic and wholly justifiable pride in pointing out the variety of the products and the excellence of the workmanship exhibited in the collection of articles sent by his state. These include articles of clothing of all kinds, of silk, cotton, woolen, linen and leather; straw and felt hats; furniture; leather and canned goods; soaps, perfumery and drugs; glassware; pianos and musical instruments; preserves and pickles; cigars and tobacco; articles of horn; books; artificial flowers; furniture; papers; brushes; beer and wine; flour; crackers of all sorts. It is clear enough that European manufacturers will soon have to meet strong competition here in Brazil. As the writer's guide proudly said: "We make just as good biscuit, and just as many varieties, as the English do." The state of San Paulo, next south of Rio de Janeiro, makes an exhibit which is fully as complete and as varied as that of Rio Grande do Sul. On the other hand, we have the exhibit of that great northern state, Amazonas, whose name at once brings up vistas of immense tropical forests, with their precious woods of all kinds, and especially with their most precious rubber—the rubber which is causing so much jealousy about national boundaries in South America; the rubber to secure which men are being held in slavery as harsh and cruel, probably, as any slavery ever was in the world. An "Inferno Verde" the life of these rubber-collectors doubtless is. Such is the title of a recent book on this subject which is attracting attention here in Rio. Its cover-design is the figure of a naked Indian woman, bound hand and foot to a rubber-tree, her blood dropping out, from many wounds, into the little tin cups used in collecting the precious sap of the rubber-tree. The Amazonas exhibit gives a good opportunity to see how this famous—or infamous—rubber is collected and prepared for shipment. A rubber-tree, with a gash, and the little tin cup shows the first stage. Bottles of the milky sap, "rubber-milk" they call it, show the rubber as it came from the tree. This liquid is then carried to be smoked and dried; and is rolled up into great bales for shipment. One of these huge oval masses of rubber, weighing 800 kilograms, forms part of the Amazonas exhibit. All these steps are well illustrated by photographs. Amazonas is typical of the non-industrial states. It is rich in woods. The present exposition includes 200 specimens of these woods, ranging from those which are soft and light and porous, to the very dense and very heavy *pao ferro* (iron-wood). The brilliant feathers from the Amazon forests, wonderfully colored, would arouse the anger of our Audubon Society members, especially if they were told that many of these feathers go to the United States. Even Amazonas is not wholly destitute of manufactured articles, although they are few in number and mostly of a primitive kind. As one runs over the exhibits from the states situated successively farther and farther south,

the industries increase, until, in San Paulo, Paraná, Santa Catharina and Rio Grande do Sul, they reach their maximum variety and highest development. Rich in promise for the future is the immense western state of Matto Grosso, across which a new railroad line has recently been surveyed, to connect the railroads of San Paulo on the east with those of Bolivia on the west. Matto Grosso sends to this exposition

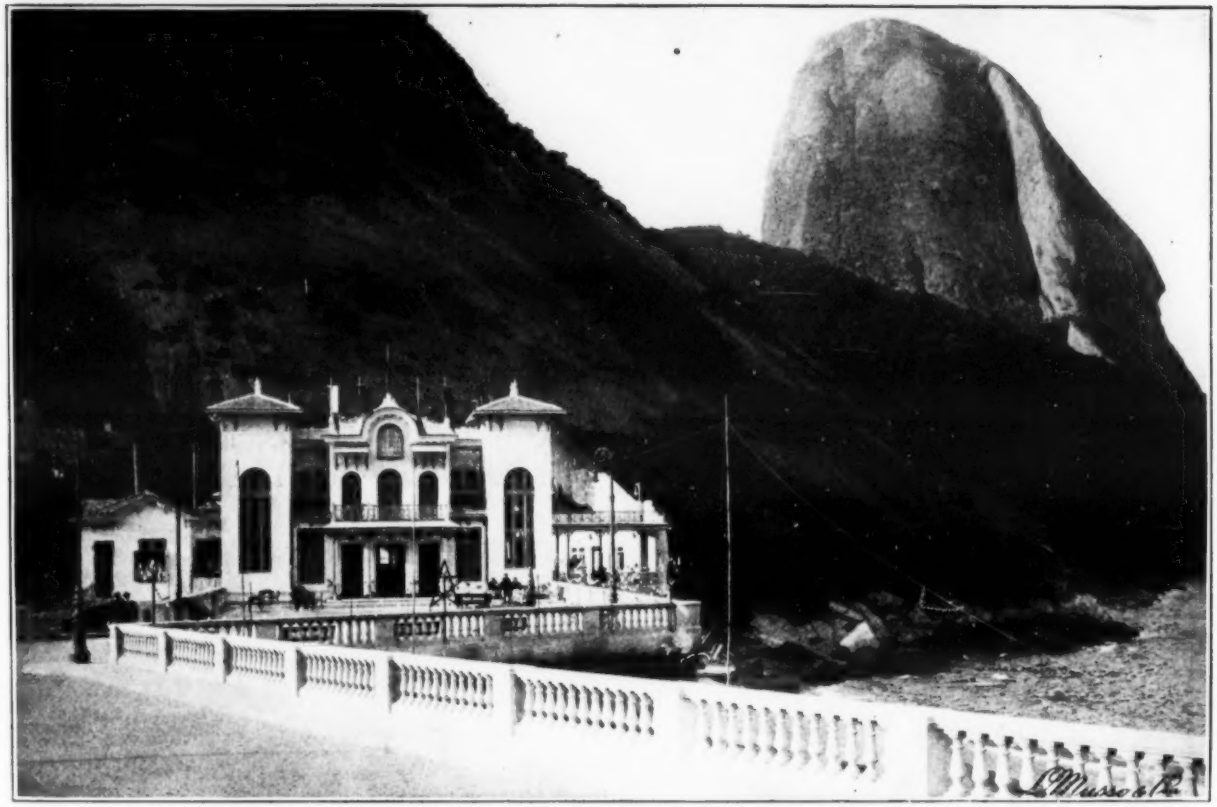
THE MINAS GERAES BUILDING.

A stately and solidly constructed building, expressing the power and wealth of the great central State. It was designed by the Brazilian architect, Rebecchi.

specimens of its sugar and farina and rice and corn; of its herbs; and of its woods, including the famous *quebracho* and shows, by means of photographs, some of its great herds of cattle. The state now has

3,000,000 head of cattle. Rio Grande do Sul has a fine exhibit of live cattle. Special mention may be made of the thoroughbred Durham and Hereford bulls, of which a considerable number are shown.

Whoever thinks of Brazil thinks of coffee, and whoever thinks of coffee-production in Brazil thinks of the state of San Paulo, the greatest coffee-growing district in the world. In the San Paulo exhibit the visitor will see bag after bag, and sample after sample, of coffee, of all grades, varieties, qualities, prices—confusing monotonous, if you will, but very instructive. A large diagram, hung on the wall, shows the export of coffee from Brazil in the year 1906–7. The total amount exported was 20,190,000 sacks, of 60 kilograms each. Santos, the world's greatest coffee port, exported 15,392,000 of these sacks. All countries outside of Brazil exported only 3,595,000 sacks. In this diagram these various amounts are represented by small coffee sacks, and each of the sacks of the diagram really represents 50,000 sacks of 60 kilograms each! Whether the traveler to Brazil can manage to get into the coffee district or not, he should surely not fail to see Santos. As the steamer comes up to the city through the narrow channel, winding about through green fields, one wonders where this famous coffee port is, of which every one has heard so much. You see some houses in the distance, very unattractive to the eye, and are told that is Santos. Your surprise continues to grow until, on making a final turn in the river you see, stretching out on your left, the famous Santos docks and warehouses, with steamers of all sizes and of many flags, lying two deep in many cases, the whole length of the docks. Everybody is busy. Teams, and mule-carts and donkey-engines and traveling cranes and porters—all busy loading coffee. Coffee is everywhere: in the streets, in the stores, on the train. If coffee is injuring the human race, Santos is doing its best to accomplish that purpose. From Santos to San Paulo there is a fine railroad journey up across the Serra do Mar; a steep climb, by cable road, to 2,500 feet above sea level. This trip should be taken by the late afternoon train. The contrast between the hot muggy air of Santos and the cool, fresh air on top of the Serra is then most striking and refreshing; the light on the mountains is then softest and most varied. The views down into the valley, with its many banana plantations, are very fine, and even the least observing traveler can not fail to notice the extraordinary precautions which have been taken to guard the line against washouts. The whole mountainside is actually walled up, in places, and everywhere are seen the brick and cement drains and ditches which carry off the rainfall. One of the engineers of this road says that the ideal for which he is striving is to know what will become of every drop of rain that falls on these mountain slopes! To maintain this line, in good order, is one constant struggle against the destructive action of



RESTAURANT "PÃO DE ASSUCAR."
The restaurant is situated at the northern end of the esplanade *Fraia Vermelha*. In the background is the Pão de Assucar (Sugar Loaf), one of the natural features of the exposition grounds.

rain-water, which is flowing downhill—nothing more—and, unfortunately for the railroad, nothing less!

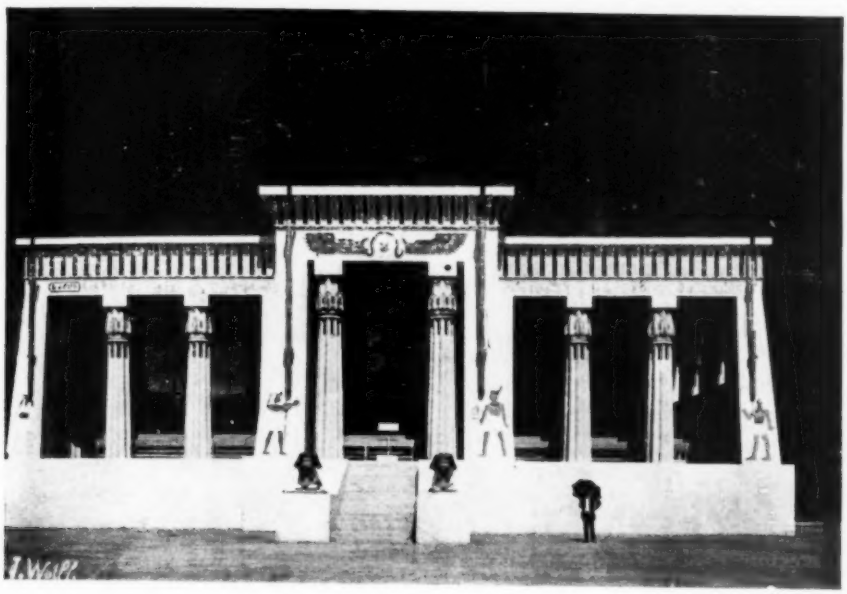
Another exhibit, mention of which is suggested by the above note on coffee, is that of maté. Barrels and bags and smaller samples of maté are seen best in the exhibits of the state of Paraná. The common name for maté, "Paraguay tea," associates this plant with Paraguay, but Brazil is becoming a more and more important maté-producing country. When white men came to these parts of South America, the Indians were found to be drinking maté, and the Jesuit missionaries soon discovered the excellent properties of the plant and forthwith adopted the native custom of using it. The maté tree grows to be 10 to 20 feet high; its natural habitat is on the plateaus 1,500 or more feet above the sea, and chiefly in Matto Grosso, Paraná and Paraguay. It is now extensively grown on plantations. Advocates of the use of maté as a drink, in place of tea and coffee, have gone very far in attributing to this herb medicinal, nutritive and stimulating qualities which would seem to make maté an absolute essential to health and happiness. The writer has before him at this moment a report on maté, made to a commercial and industrial body in Paraná a few years ago, and in this account the benefits to be derived from the use of maté tea are enumerated at great length. But whether these beneficial qualities are exaggerated or not, the fact remains that maté-drinking is very much on the increase, and that those who indulge in it are practically unanimous in stating that maté is far superior to tea, in not producing insomnia or nervousness. Americans who want to see a maté factory will do well to visit Curityba, the capital of the state of Paraná. There the "Fabrica Tibagy," one of the largest in Brazil, will be freely opened to their inspection. This factory exported last year 3,000,000 kilograms of maté, the whole amount exported from Paraná being 30,000,000 kilograms. The leaves and small stems are brought to the factory in burlap or rawhide bags, and after being thoroughly dried, in ovens, are passed through a screening process, which separates the stems and leaves, according to their size. The coarsest stems are used for fuel; the less coarse ones are sold for the cheaper grades of maté. The leaves are then carefully sorted, according to their quality, and are next run through crushing machines. The best maté is in the form of a very fine olive-green powder. Maté tea is prepared much like ordinary tea. It may be taken in a cup, if properly strained, but the native way is to leave the powder in the water and to suck up the tea through a tube provided at the lower end with a fine strainer. The taste of maté to the novice is not unlike that of a very weak solution of hot turpentine. It is therefore safe to say that maté-drinking is an acquired taste for those who are accustomed to ordinary tea. Most of the Brazilian maté goes at present to the

Argentine Republic, but some is already being exported to France. The visitor to Curityba should, by all means, going or coming—preferably both going and coming—take the trip by rail between Curityba and Paranaguá. This is without question one of the most picturesque railroad journeys in the world. From Paranaguá, on the coast, the railroad ascends the splendid range of coast mountains up to a height of about 3,000 feet above sea level, by a long series of curves, tunnels and bridges which are marvels of engineering skill. Bare rock, mountain torrent and waterfall, forested slope distant views over the deep valleys and plains below, follow one another in rapid succession for two hours. On the lowland and lower slopes you see, in the greatest profusion, oranges, bananas and sugar-cane. On the way up you pass through a densely-tangled forest, whose trees are almost completely covered with moss, creepers and parasitic plants of all kinds. Once across the top of the mountains you find yourself on a campo—rolling; sparsely wooded, very bare by contrast. Very few American tourists ever take this journey. But one can hardly be said to have seen anything of Brazil who has not been farther inland than the immediate sea-coast, and it is in the coast cities that most travelers spend their time.

American visitors to this exposition will be especially interested in the exhibit of the experimental rice farm at Moreira Cesar, in the state of San Paulo. On this farm, with the aid of irrigation, our fellow countryman, Mr. Wellman Bradford, of Louisiana, is carrying on an experiment station where students, selected by the government, are being taught scientific rice-growing. Mr. Bradford has had many difficulties to contend with in his work, but he has faithfully persisted in his undertaking, and deserves the greatest credit for his skill and perseverance. Japanese rice, which has lately been sown on this farm, has been found to give the best results as to quality of the crop. Another exhibit of interest to Americans is that of the model farm at Piracicaba, in the state of San Paulo. This farm is carried on, as is the rice farm just referred to, under government auspices. Its director was formerly at the Michigan Agricultural Experiment Station. Cereals of many kinds are raised, as well as cotton, rice, sorghum and alfalfa. Experimental plantings of various kinds of wheat and corn from the United States are being made, and the people who come to the farm are being taught modern methods of farming, and stock-raising. No more important work for the agricultural future of the country here in Brazil is being done than that now in hand at the rice farm at Moreira Cesar, and at the Fazenda Modele at Piracicaba.

The National Exposition at Rio de Janeiro, taken all in all, is immensely significant, instructive, impressive. It tells of the natural wealth of Brazil; of the variety of its products; of the many arts and

industries that have here been developed almost wholly without the knowledge of the bulk of the people in whose midst the factories and mills and machine-shops have sprung up. It is fitting that this exposition should take place in celebration of the centennial anniversary of the opening of the ports of Brazil to the commerce of the world. The exposition finds its appropriate location in the new Rio de Janeiro, with its new avenues and boulevards, docks and warehouses, and the many other improvements which have changed it so recently into a modern city.



A BIOGRAPHICAL HISTORY OF BOTANY AT ST. LOUIS, MISSOURI. III.

By Dr. PERLEY SPAULDING

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EXPLORATION in the Missouri country was commenced in 1835 by Karl Andreas Geyer, a collector who became well known for his botanical explorations in the northwestern section of the United States. His explorations extended over a number of years and ranged from Illinois westward to the Pacific. He traveled especially in the territory included between the Mississippi and the Missouri River as far north as North Dakota.

Karl Andreas Geyer[12] was born in Dresden, Germany, on November 30, 1809. His father was a market gardener of very moderate circumstances. The boy was naturally bright and studied Latin under the tutelage of a kind-hearted man who helped him with his lessons, which were studied while he was selling his father's produce in the streets of the city. In 1826 he entered the garden at Zabelitz as an apprentice. In 1830 he removed to Dresden and engaged as assistant in the botanic garden there. In this place he had numerous friends, among whom was Dr. H. G. Reichenbach, whose lectures upon botany he attended with great regularity. He seems to have been a very likable and attractive person, drawing the attention of those with whom he came in contact. In February, 1834, he left Dresden for America. Here he collected plants during the summer months and worked at odd jobs in the winter, thus maintaining himself for several years. In one case he entered a newspaper office as compositor, but a few months later he was writing the leading articles for the same paper that he had helped set in type.

Geyer's first great journey in this country was in 1835, when he visited and explored the plains of the Missouri with a single companion. In 1836 and the succeeding years he went with Nicollet surveying the country between the Missouri and the Mississippi River. In 1840 he collected around St. Louis and in Illinois, making very considerable collections during this season. While in St. Louis he became acquainted with Dr. George Engelmann and this friendship seems to have lasted as long as Geyer was in this country. Engelmann seems to have worked over his collections, as we find him publishing upon them

[12] Anonymous, *Chronik des Gartenwesens*, 3: 185–187, 1853.
Reichenbach, H. G., *Kew Garden Miscellany*, 7: 181–183, 1855.

in 1844. He also came into possession of some of Geyer's collections, as it is definitely stated that they had been deposited in the Engelmann herbarium.

In 1841 Geyer went with Fremont to the Des Moines River in Iowa territory, where he found a number of new plants. In 1842 he explored the upper Illinois territory and formed the herbarium which was first offered for sale. In 1843 he began the journey from Missouri to the Pacific coast, lasting through the years 1843 and 1844. He explored the northwestern country very extensively and penetrated to hitherto inaccessible places by accompanying missionary trains on their visits to the different Indian tribes. He finally reached Fort Vancouver, and from there sailed on November 13, 1844, for England, going by way of the Sandwich Islands and Cape Horn. He arrived in England May 25, 1845, and spent some months at Kew, working over his collections and sorting out small lots of plants to sell. A large part of his profits from such sales was used in defraying expenses caused by a sickness brought on by his previous hardships. In September, 1845, he again returned to his home in Saxony, after an absence of eleven years. At first he entered the employment of head-gardener Lehman in Dresden, and later in the Royal Botanical Garden. His wanderings had shown him the value of a home, and on August 24, 1846, he married Miss Emma Schulze. Besides his duties for the garden he taught students the English language, his pupils coming from every class in Meissen. Geyer also took a prominent part in the local society for the advancement of science. During the last three years of his life he was editor of *Chronik des Gartenwesens und Feuilleton der Isis,* a periodical published at Meissen on the first and fifteenth of the month, from January 1, 1851, to December 15, 1853. Geyer's death occurred just before the end of the third volume, and it was discontinued with the third volume. While in no wise neglecting his duties at the garden, he came in written communication with the prominent botanists of the time and rounded out his collections. Heart disease troubled him considerably in his latter days and finally caused his death on November 21, 1853.

In 1835 a physician, George Engelmann by name, settled in St. Louis and soon built up a lucrative practise. During his spare moments he worked upon botanical problems, and before long he had established a reputation among botanists such that at his death he was ranked among the foremost of botanical workers.

Dr. George Engelmann[13] was born at Frankfort-on-the-Main, Feb-

[13] Gray, Asa, *Proc. Amer. Acad. Arts and Sci.*, 19: 516–522, 1884.
Sander, Enno, *Trans. St. Louis Acad. Sci.*, 4: 1–18 (Supplement).
Anonymous, POP. SCI. MONTHLY, 29: 260–265, 1886.

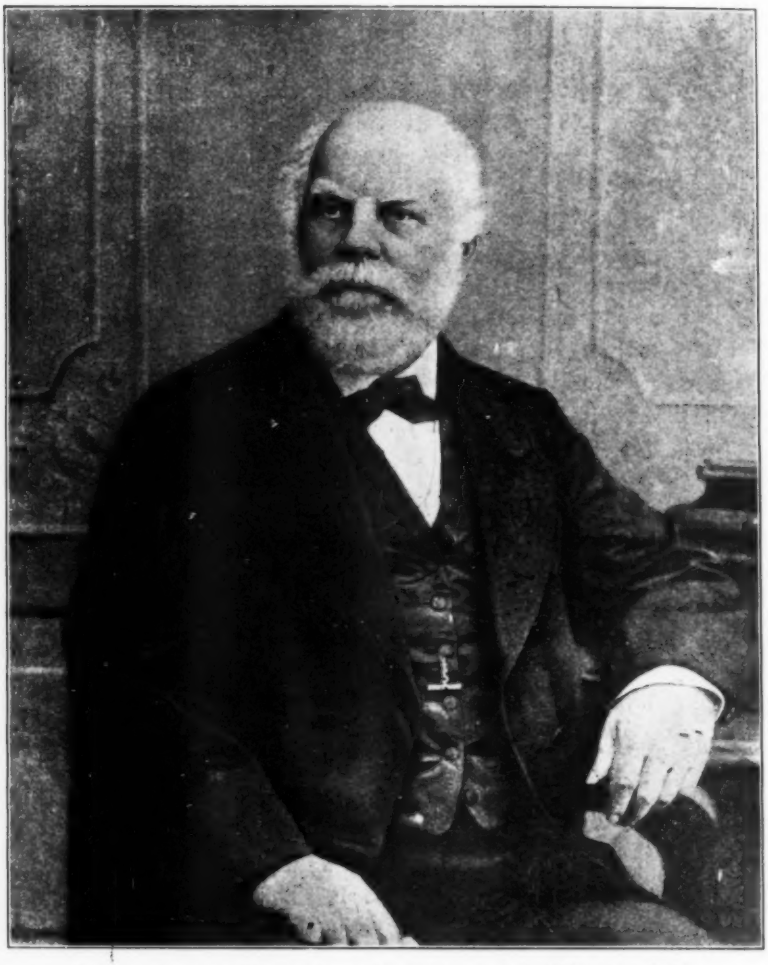

FIG. 9. DR. GEO. ENGELMANN; by courtesy of the Director of the Missouri Botanical Garden.

ruary 2, 1809. He was the eldest of thirteen children. Aided by a scholarship he went to the University of Heidelberg in the year 1827, where he had as fellow-students and companions Karl Schimper and Alexander Braun. Political embarrassments caused him to go in the autumn of 1828 to Berlin University for two years, and finally to Würzburg, where he took his degree of Doctor of Medicine in the summer of 1831. His inaugural dissertation, "De Antholysi Prodromus," published at Frankfort in 1832, testifies to his truly scientific mind.

Trelease, Wm., and Gray, Asa, "Botanical Works of Engelmann," 1–548, 1887.

Sargent, C. S., "Silva of North America," 8: 84, 1895.

White, C. A., "Biogr. Mems. Nat. Acad. Sci., 4: 3–21, 1896.

It is a morphological study founded chiefly upon monstrosities, and it had the honor of receiving the notice and approval of Goethe, who offered to place in Engelmann's hands his notes and sketches, which intention was frustrated by his death before it had been carried out. This first paper has been very favorably commented upon, and compared with much more extended and pretentious works of a similar nature.

The spring and summer of 1832 were passed at Paris in medical and scientific studies with Braun and Agassiz as companions. He then became the willing agent of his uncles, who had resolved to make some land investments in the Mississippi Valley, and he sailed from Bremen for Baltimore in September. He joined some of his relatives

FIG. 10. RESIDENCE OF DR. GEO. ENGELMANN IN ST. LOUIS, MISSOURI; by permission of the Director of the Missouri Botanical Garden.

who had previously settled in Illinois near St. Louis, and made lonely journeys on horseback through southern Illinois, Missouri and Arkansas. He finally established himself in St. Louis as a doctor of medicine late in the autumn of 1835. At this time St. Louis was a frontier town of eight or ten thousand inhabitants. Beginning in poverty, he soon built up a large practise and so established himself in his profession that he was able to go back to Germany for some months. While there he married his cousin, Miss Dora Hartmann, in June, 1840.

Again in 1856 he left his practise for a two years' absence, devoting

the first summer to botanical investigations at Cambridge, and then visiting his native land in company with his wife and son. In 1868 the family again visited Europe for a year, the son remaining to study at Berlin. The mother died in January, 1879, and Englemann's own health failed alarmingly. A journey to Germany was taken in 1883 and the voyage was so beneficial that he was able to resume his botanical work. Serious symptoms soon caused him to return and the ocean voyage again proved very restorative and he resumed his labors with increased vigor. Increasing infirmities, however, gradually reduced his working powers until his death, which took place on February 4, 1884.

Upon first coming to this section of the country Dr. Engelmann traveled on horseback through southern Illinois and in Missouri and Arkansas; and during the latter part of his life he explored the mountains of North Carolina and Tennessee, the Lake Superior region and the Rocky Mountains and contiguous plains in Colorado and adjacent territories, thus being able to study in place, and with the acuteness of judgment which characterized his work, the Cacti, Coniferæ, and other groups of plants which he had investigated for years. In 1880 he made a long journey through the Pacific states, where he saw for the first time growing naturally many plants which he had described and studied over thirty years before.

Dr. Engelmann's papers are voluminous even for a man who could devote all of his time to botany; but it must be remembered that he had a large practise as a physician, which took most of his time, and that botany was taken up only in spare moments. When this is taken into account, together with the fact that he was also interested in other sciences (especially meteorology), their extent is nothing short of marvelous. The memorial volume of his papers published by Henry Shaw contains eighty-seven different papers of varying length. These have been grouped in this volume under the following headings or general topics: Cuscutineæ, Cacteæ, Juncus, Yucca and Agave, Coniferæ, Oaks, Vitis, Euphorbiaceæ, Isoetes, Miscellaneous, Lists and Collected Descriptions of Plants, and General Notes. It was the custom of Dr. Engelmann to take any scrap of paper and make notes upon it which might occur to him, together with sketches showing characters of the plant in hand. All such notes were at his death collected and mounted in a set of large books which are now in the possession of the Missouri Botanical Garden. These notes were so numerous that they made a library in themselves, filling sixty of these books.

His method of working was to take a single group of plants and work it out systematically so far as was in his power. His treatment of the genus *Cuscuta* in his first monograph of that group increased the number of species from one to fourteen without going west of the

Mississippi Valley. Seventeen years later, after an investigation of the whole genus in the principal herbaria of this country and of Europe, he published a systematic arrangement of all the Cuscutæ, giving seventy-seven species, besides a number of varieties.

Dr. Engelmann's authority upon the *Cactaceæ* was of the very highest. He established the arrangement of these plants upon floral and carpological characters. This work was carried on through a series of papers beginning with his sketch of the botany of Dr. A. Wislizenus's expedition from Missouri to northern Mexico, and continued in his account of the giant cactus of the Gila, in his synopsis of the Cactaceæ of the United States, and in his two memoirs upon the southern and western species contributed to the Pacific Railroad Reports and to Emory's "Report on the Mexican Boundary Survey." He had made preparations for a revision of at least the North American Cactaceæ, but upon his death much knowledge of this difficult group was lost.

FIG. 11. NICHOLAS RIEHL; from a photograph kindly loaned by his son, Mr. E. A. Riehl.

His papers on the American oaks and the Coniferæ are of the highest interest, and are some of the best specimens of his botanical work; and the same is also true of his study of the vines. Nearly all that we know of this genus scientifically is directly due to Dr. Engelmann's investigations.

His work is characterized by a minuteness and carefulfulness of observation, coupled with a nicety of discrimination which made him a master in systematic work, his treatment of the yuccas and agaves, the genera *Juncus, suphorbia, Sagittaria, Isoetes,* the *Loranthaceæ, Sparganum* and *Gentiana* giving him an eminence among fellows botanists to which few attain. His name was upon the rolls of many societies devoted to the investigation of nature, and he was the recognized authority upon those departments of his favorite science which had most interested him. His name has been given to a monotypical genus of plants, *Engelmannia,* by Torrey and Gray. Numerous species also bear his name.

Shortly after Dr. Engelmann settled in St. Louis, Nicholas Riehl.

a native of France, came to his city and settled on a piece of land on the Gravois Road in South St. Louis, and began to collect botanical specimens.

Nicholas Riehl[14] was born in Colmar, province of Alsace, France (now Germany), about 1808. His father's business was that of manufacturing cloth; not liking it, Nicholas sold it after the death of his father, and divided the estate. He took his share and traveled over much of Europe and America, coming as far west as St. Louis. Taking a liking to this part of the country, he returned to his old home and married. The two returned to St. Louis in the spring of 1836, and settled on a piece of ground on the Gravois Road in Carondelet, just outside the St. Louis city limits, and established a nursery. This is believed to have been the first nursery in St. Louis county, if not in the state of Missouri. The nursery business he carried on with success and profit until the time of his death in September, 1852. Riehl evidently collected botanical specimens some years before he came to this country, as specimens in his herbarium bear dates as far back as 1830, which were collected in the vicinity of Colmar. He also collected considerably in the vicinity of St. Louis in 1838. He had printed labels made for the collections made in this year, and they number not far from two hundred. Besides the specimens bearing the printed labels, there are many with incomplete labels which undoubtedly were collected here also. His entire collection was sold to Mr. Henry Shaw, who was at that time just starting to develop his botanical garden. The larger part of them were collected in Europe or were exchanged with European collectors. Mr. Riehl was a friend and admirer of Dr. George Engelmann, and was much interested in the work which he was doing. The Riehl nursery furnished Mr. Shaw the first trees which he planted in his newly started botanical garden.

In the forties Theodore C. Hilgard was collecting the native plants of the vicinity of St. Louis.

Theodore Charles Hilgard[15] was born at Zweibrücken, Rhenish Bavaria, on February 28, 1828. His father, Theodore Erasmus Hilgard, was a lawyer, who in 1836 resigned from the Supreme Court of the province and emigrated with his family to America, settling on a farm near Belleville, Ill., which at that time was the home of many other educated Germans who for political reasons had preceded him. Theodore was the sixth of a family of eight. The schools being poor and few in number, Theodore with the other younger children received his primary education from his elder sisters and elder brother Julius,

[14] Information and photograph supplied by Mr. E. A. Riehl, of Alton, Illinois, son of Nicholas.

[15] This sketch is adapted with very slight changes from a manuscript kindly furnished by Professor Eugene W. Hilgard, brother of Theodore.

while all received their higher training, especially in the languages, from their father. The boys aided in the farming operations and Theodore early manifested a marked interest in the natural sciences, and especially in botany; in which, however, his father could not help him. He soon found an enthusiastic helper in his younger brother Eugene, and together they made extensive collections of the native plants and insects of the vicinity. Dr. George Engelmann, a second cousin, greatly assisted the boys in their botanical studies.

Early in 1847 Theodore went to Europe and entered the University of Heidelberg as a student of medicine. Henle, Chelius and Hasse then made Heidelberg the most notable center for medical study outside of Vienna, while Bischoff represented botany. Hilgard at once began to make what subsequently became a very complete collection of the flora of central Europe. The revolutionary agitation of 1848 somewhat disturbed the regularity of the course of study, but no actual interruption occurred until, in the spring of 1849, active revolutionary movements took place in Baden itself. Theodore then (with his brother Eugene, who had meantime joined him) went to Zürich, and there passed three semesters, studying especially microscopy under Naegeli, and physiology under Ludwig, besides attending the natural history lectures of Oken. During this time the brothers made extended excursions on foot through Switzerland and collected the Alpine flora. In 1851 Theodore went to Vienna to study, where were then such medical celebrities as as Rokitansky, Oppolzer, Bednar and Hebra. After nearly two semesters, during which he gave much time to botanical study in the great Endlicher collection, he was obliged to go to Malaga to bring back his widowed sister. While there he made an extensive collection of Mediterranean plants which greatly interested him. On his return he went to Würzburg, where he graduated in June, 1852, *summa cum laude,* as doctor in medicine, surgery and obstetrics. He then went to Berlin to study ophthalmology with Graefe, as well as surgery. In the summer of 1853 he returned to America, taking a position as ship physician on an emigrant vessel, on which he experienced an epidemic of cholera.

FIG. 12. DR. THEODORE C. HILGARD; by courtesy of Dr. Eugene Hilgard.

Soon after his arrival he went on a visit to the west to see whether he had best practise his profession there. On the way he sustained a severe shock to his spine in a steamer accident. It took him several weeks to recover somewhat, but he never fully recovered. He was disappointed in the outlook and returned to the east, where he took up practise in Philadelphia. There he became a friend of Elias Durand, a druggist and botanist, who in the latter capacity was requested to elaborate the botanical collections made by Heermann while with the Williamson Pacific Railroad Expedition. Durand proposed to Hilgard that they should collaborate in this work, and the latter being by nature an expert draughtsman, he not only described, but drew the illustrations of a large number of the "Plantæ Heermanianæ" accompanying the final report of the expedition. The strain of this work seemed to develop the spinal injury into a serious inflammation, from which he was prostrated for months. After recovery which was, however, never complete, he resolved to begin practise in St. Louis, and removed there in 1855.

He continued to practise in St. Louis from that time until 1870, much handicapped by the spinal weakness which obliged him to refuse much lucrative practice. His spare time was chiefly devoted to botanical studies, now more especially to the cryptogams, whose development he studied under the microscope, in the use of which he became very expert. In these studies he found that the then current classification and nomenclature of these organisms was seriously at fault, many merely developmental forms being classed as separate species, genera and even orders. He also worked zealously in devising a system of arrangement of the phanerogams which would express their mutual cross relations, the best graphic presentation of which on a flat surface he found in the pentagrammatic form. Comparative anatomy and the homotaxy of organs and structural parts also formed a favorite subject of investigation. Most of his work on these subjects was published in the *Proceedings* of the St. Louis Academy of Sciences, of which he was a charter member; also in the *Proceedings* of the American Association for the Advancement of Science and in the *St. Louis Medical Reporter*. He also helped in the organization of the "Humboldt Institute" library which for some time had a very useful cultural influence. In 1865 he married Miss Georgina Koch, daughter of Mr. A. Koch, of *Zeuglodon* fame. No children came of this union.

As the state of his health precluded his acting as an army surgeon, he remained at St. Louis during the war in hospital and private practise. After the war medical practise seemed to become more and more incompatible with his strength, and he gave it up and joined his brother Eugene at the University of Mississippi, where at that time a lectureship of botany was contemplated. But it failed of realization, and he

accepted a position in the U. S. Coast Survey as observer in the magnetic survey then being made on the basis of the "Bache Fund." In this he continued until 1873, when he found it necessary to settle to a quiet life. The last year of his life was passed at New York City, where in March, 1875, he died of an abscess of the lungs.

The Hilgard collection of plants, embracing about 12,000 species, was taken by his brother Eugene to the University of California, where it was destroyed by fire in 1897.

Shumard in his presidential address before the St. Louis Academy of Sciences in 1869 spoke as follows concerning a collection of plants given by Hilgard to the Academy:

> Our botanical collection embraces an extensive series of lichens and mosses amounting to several hundred species, chiefly from western states and territories. These were collected by Dr. T. C. Hilgard, of this city, and by him presented and arranged in our museum.[16]

In the fire which destroyed part of the academy museum a few years later, this collection was also destroyed.

[16] Shumard, *Trans. St. Louis Acad. Sci.*, 3: XII., 1869.

(To be continued)

THE LATEST CALABRIAN DISASTER

By Professor WM. H. HOBBS
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NOW that more reliable accounts have reached us of the terrible disaster to Calabria and Sicily, it is possible to discuss some larger facts which seem to be revealed with clearness. The grand eruption of Etna, the disappearance of the Eolian islands, and other equally improbable rumors, have ceased to be valuable scareheads in the newspapers. The death loss it is still too early to properly estimate, but on the basis of a well determined law of news reporting, it is safe to say that the larger of the estimates will be much reduced. Many that have been reported killed will eventually be classified among the maimed and wounded, and many communes now supposed to be in as great plight as their near neighbors, will be found either to have received but slight damage or even to have remained immune. Such has, at least, been the history of the earlier Calabrian earthquakes.

A number of large towns at first reported destroyed as a result of the Calabrian earthquake of September 8, 1905, the writer found on visiting them a few weeks later had escaped without injury of any kind. The reported death roll fell from many thousand to 3,000, then to 1,500, and finally to 529, the last figure, that of the official count by communes.

Yet, notwithstanding this history there seems no reason to doubt that the death loss from the recent shocks will mount far into the tens of thousands. The greatest of previous disasters from this cause within the same region occurred in February and March, 1783, at which time the death roll was 29,515 (as finally counted by villages) and the property loss $26,000,000. This was, however, one of the greatest earthquake disasters of history, for recent extended studies by Woehle have shown that Lyell's estimate of 60,000 for the deaths caused by the Lisbon earthquake of 1755 should be divided in half. In this instance the estimates of deaths which were made at the time ranged all the way from 25,000 to 150,000.

One can not read of the rush of Italy's king and queen to the succor of their pitiably afflicted subjects, and of their remaining among them with considerable danger to themselves, without realizing that there is much of the heroic in it. The traditions of an almost parental relationship to their subjects, have thus been well maintained through

the inspiration of their presence and their magnificent personal courage. The actual conditions have been terrible enough, but apprehensions of phantom dangers flourish amid ignorance and superstition, and in Italy the inspiring example of the sovereigns is hardly less important to operations of succor than are the rescue corps and their supplies. It was the writer's fortune to follow somewhat closely in the footsteps of King Victor Emanuel and Queen Helena after the Calabrian earthquake of 1905, and again after the Vesuvian outbreak of the following year, on both of which occasions a similar impulse carried them at once to the afflicted districts. As a result of this experience the writer has only admiration for their conduct.

A further word may be added concerning the work of the troops which were then engaged in rescue operations, since their conduct has been unfavorably commented upon in some quarters. The writer had ample opportunity to observe their work and would submit that the army acted not only with vigor and effectiveness, but upon a thoroughly scientific plan. There is, therefore, every reason to believe that all which is possible will be done by the Italian government in the face of the much greater catastrophe which it is now facing.

It is, however, beyond Italy's power to properly meet this disaster without some help from the outside world. The first supplies of food and of hospital stores, it may be expected, will be contributed in sufficient quantity, for the horror of the event has stirred the entire western world. The greatest pinch of poverty and starvation will come when the great wave of emotion has passed and the future alone is to be considered. To properly appreciate this, it is necessary to consider the normal economic conditions and the recent physical history of southern Italy.

Calabria and northeastern Sicily, the provinces affected by the earthquake, are overpopulated, and from them there has been much emigration to the United States and to South America. The chief sources of income are the culture of the olive, fig, the citrus fruits, and the cereals, and in Sicily the mining of sulphur. As regards fruit and cereal culture, the peculiar conditions of farm tenure are such that even under favorable circumstances a large part of the population is kept on the verge of poverty. The sulphur mining in Sicily is carried on in a small way over most of the interior, and until a few years ago was a fairly profitable industry. Now, however, the use of pyrites as a substitute for sulphur in the manufacture of vitriol, and the recent successful exploitation of the vast sulphur deposits of Louisiana, have so reduced the price of sulphur as to threaten the only means of livelihood of a large part of the Sicilian population.

In contrast to southern Italy, the conditions of living in the northern provinces are good, and it has long been necessary for the north

Italians to contribute to the support of their compatriots in Calabria and Sicily. As a result of this burden, a strong party in the government has long been advocating a separation of the two sections, which would leave Calabria and Sicily to care for themselves.

To these discouraging general conditions must be added a series of special calamities which have befallen southern Italy since the summer of 1905. In September of that year, without warning of any kind, came the blow of the great Calabrian earthquake, the shocks of which destroyed property to the value of nearly $10,000,000, besides leaving a long list of killed and wounded. Both government aid and large private subscriptions from the northern provinces were necessary in order to succor the victims and in part to rebuild the ruined villages.

In the following spring heavy rains largely ruined the crops in Sicily, and in April occurred the great eruption of Vesuvius which spread a mantle of ash on the flanks of the mountain, so as to bury the vineyards and remove for some years the sources of livelihood. Many thousand people who dwell upon the flanks of the volcano were thus thrown upon the government for support and the more favored Italians in the northern provinces were obliged to make further sacrifices for their relief.

What, we ask, is Italy to do in the face of the new disaster, following as it does so swiftly upon the heels of the others, and dwarfing them by its proportions. It avails nothing now to argue that much of the loss of life and property might easily have been avoided, had buildings suited to such a seismic district been constructed. This fact has again and again been pointed out by properly qualified persons after each fresh disaster, but the force of inherited tradition is not so easily turned aside, and it was only after the earthquake of 1905 that the beginning of better things was seen. Then in place of the loose stone and tile houses—veritable man deadfalls—which have again and again been raised over their own ruins, strong wooden barracks were constructed under government supervision. It is, however, only in such towns as were largely destroyed in 1905 that such reform measures have been adopted.

Leaving now the humanitarian side of this calamity we may turn to its scientific aspects. Enough is already known to state that the site of the heaviest movement lay in and about that small arm of the Mediterranean which separates Sicily from the mainland of Italy—a section of crust, therefore, which immediately adjoins upon the west that which was heavily shaken in the fall of 1905. This fact, no doubt, helps to explain the otherwise exceptional character, since a destructive earthquake is apt to be followed by a rather long period of comparative quiet, so soon as the so-called aftershocks have faded away. The great

earthquake of 1783 possessed likewise this double character, but in that instance also the areas of the heavy shocks were distinct though adjacent.

For purposes of study the latest Calabrian earthquake appears to offer some exceptional opportunities. The peculiar outlines of the two land masses which are involved render them specially open to study from the sea as a base. The full importance of this fact will be appreciated by any one who has been compelled to find accommodations where only the ruins of hotels exist. Under such circumstances one must proceed on foot or with a donkey, carrying supplies of bread and wine with him.

A scientific party engaged in studying the Calabrian earthquake could live for most of the time upon a vessel from which the shore would be reached either at the numerous ports or by launches. If a government vessel is to be sent with supplies to the afflicted district, the opportunity should not be lost to despatch a scientific party aboard her.

For another reason the recent earthquake offers unique opportunities for study. It has long been known that the straight eastern coast line of Sicily corresponds to a great zone of faulting within the earth's crust, and more than once in the past the slips upon it have brought disaster. On at least one such occasion, the sea bottom between Messina and Reggio and between Charybdis and Scilla has been considerably modified. In the vicinity large strips of cliff have slipped down into the deep sea at their base. A primary object of a scientific party charged with the investigation of this earthquake should, therefore, be to carry out an elaborate series of soundings in waters within and about the straits of Messina. Fortunately the dangerous nature of this channel is responsible for accurate data which represent the late condition. We have, therefore, here the opportunity of determining by a simple re-survey the changes which are ascribable to the recent earth disturbance.

A second section of the expedition should have for its chief object the preparation of maps of all portions of the shores or inland areas which reveal any change of configuration as a result of the earthquake. One of the most difficult of questions which arise in connection with earthquakes is to determine the exact significance of the so-called "secondary cracks." These cracks are generally found in loose materials, and the question is in how far they represent the projection upon the earth's surface of cracks within the consolidated rock below, or in how far they are due to settlement, and have in consequence less significance of orientation. This question can be definitely settled only by the aid of careful and detailed maps, which are studied in con-

nection with the fracture system of the more firmly consolidated rocks.

Either the same or a separate triangulation section of the party should have charge of the re-occupation of primary triangulation stations in order to see what changes in position and elevation of these stations are properly ascribable to the earthquake. It may well be doubted if more ideal conditions could anywhere be found for such a study. If continued changes should be found to occur during the progress of the surveys, as is by no means improbable, the opportunity thus offered to compare mass movements of the ground with the time of prominent aftershocks should be regarded as of the first importance.

In every great earthquake which is studied, perhaps the most important line of attack is found in the distribution of the surface intensity of the shocks. It is now everywhere acknowledged that this intensity or amplitude of movement (and it is on this that damage to structures depends), is in a large measure determined by the elastic or non-elastic nature of the underlying material. Amplitude of movement is least on so-called "solid rock," it is greater on non-coherent deposits such as alluvial material, and it is probably greatest over so-called "made ground," with its tin-can and crockery ingredients.

With the passing of the centrum theory it is inevitable that the study of the immediate basement of each locality should enter upon the quantitative stage of development. The local quantitative effect of the surface layers is a factor which to an approximation may be known and for this reason should be eliminated, if the seats of movement are to be determined. Local thickness and relative elasticity of the unconsolidated materials in the basement must therefore, be determined, and the value thus obtained be deducted from the total local intensity, if we are to arrive at the genesis of the disturbance. Accurate geologic maps and earlier detailed seismological studies in Calabria and Sicily are favorable to an extended study of this subject.[1]

There are few, if any, places where within a circumscribed area more elaborate magnetic observations have been carried out than about the straits of Messina. Before the earthquake of 1905 a detailed magnetic survey for this district had been completed. It is almost certain that large changes would be revealed by a new survey since it has been shown in Japan that important changes in the isomagnetics resulted from the great earthquake of 1891. The importance of magnetic records to earthquake study is each year being made more apparent.

[1] William H. Hobbs, I., "On Some Principles of Seismic Geology," with an introduction by Professor Eduard Suess; II., "The Geotectonic and Geodynamic Aspects of Calabria and Northeastern Sicily," with an introduction by Count de Montessus de Ballore. Gerland's "Beitraege zur Geophysik," Vol. 8, 1907, pp. 219–362, pls. 12.

A sixth object of study should be the tsunamis or "tidal waves" which apparently followed upon the recent shocks, since it has been demonstrated that such waves go out from the deeps of the sea apparently as the result of movements upon the floors of those deeps. That these movements are not directly connected with the land disturbances is apparent in their absolute lack of relation to such disturbances, even when the land disturbance is localized at and near the border of the sea. The California earthquake of 1906 was followed by no afterwave, though the Yakutat Bay (Alaska) earthquake of 1899 was succeeded by an inundating wave over forty feet in height.

Great deeps of the Mediterranean occur both to the north of Sicily (the Tyrrhenean deep on the site of a former land area) and also to the southeastward in the Ionian depression. Fortunately the land areas form a barrier between these deeps and furnish unusual opportunities of localizing the sea floor movements on the basis of the shore lines which have been washed by the wave. A series of soundings in these deeps, which have been already surveyed with considerable care, should afford a confirmative determination, provided changes not ascribable to errors in either series of soundings should be discovered. Such a discovery would certainly take foremost rank among earthquake investigations.

To sum up, therefore, it may be said that the proposed scientific expedition should be prepared to carry out at least six separate lines of investigation, since conditions are in all cases unusually favorable for study. These lines are: (1) a re-survey by soundings of the sea bottom separating Sicily from Calabria; (2) the preparation of precise and accurate maps by expert topographers of all sections of the land which have suffered noteworthy visible deformation; (3) the re-occupation of primary triangulation stations in the vicinity of the straits of Messina in order to determine changes in location and elevation; (4) the distribution of the damage on the land with due regard to the depth and character of superficial deposits, and further comparison of the results with those of earlier quakes within the same district; (5) a magnetic resurvey of the near shores (unless this is to be carried out by Italian workers); (6) the taking of a sufficient number of soundings over the great Tyrrhenian and Ionian deeps to determine whether changes in depth explain the after-waves of the earthquake.

As precedent for such studies conducted upon foreign soil, it should be stated that the great Andulusian earthquake of Christmas Day, 1884, was studied by a French Commission headed by Professor F. Fouqué, sent out by the Paris Academy of Sciences. The same disaster was also successfully investigated by an Italian Commission sent by the Royal Academy at Rome, and our present knowledge of this earthquake is very largely based upon the monographs which were

published by the French and Italian Commissions.[2] There is, moreover, every reason to think that the Italian government would welcome and cooperate in every way with such an expedition as is here proposed. The present writer takes pleasure in saying that his studies of the Calabrian earthquake of 1905 were aided in every possible manner by the Italian scientific societies, and by individual seismologists.

There is a further reason why such a study should be undertaken by outside parties. It is difficult for one unfamiliar with the facts to understand the vexatious delays under which Italian scientists are often compelled to carry out their work. As a result of the financial straits in which the Italian government finds itself, the publication of scientific monographs is often long delayed. The manuscript of a report upon the Calabrian earthquake of 1894 had not seen the light when the shocks of 1905 arrived. This greater catastrophe seemed to render the report of less vital importance than a new report, and two separate royal commissions were appointed to prepare a report upon the disturbance of 1905. As their report has not yet appeared it is likely to be side-tracked for the report upon the new disaster. Thus the results of much painstaking scientific work see the light only in brief abstracts, because government action is too slow or, shall we say, seismic action too frequent.

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[2] F. Fouqué et al., Mission d'Andalousie; "Etudes relatives au tremblement de terre du 25 décembre 1884 et a la constitution géologique du sol ébranlé par les sécousses," *Acad. Sci. Paris, Mem.*, 2me ser., Vol. 30, 1899, pp. 1–772, pls. 42. T. Taramelli e G. Mercalli, "I terrimoti andalusi cominciati il 25 dicembre 1884," *Atti della R. Accad. dei Lincei, Mem.*, 4th ser., Vol. 3, pp. 116–222, pls. 4.

JEFFERSON DAVIS'S CAMEL EXPERIMENT

By Professor WALTER L. FLEMING
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WHEN Jefferson Davis was secretary of war he inaugurated an interesting and important experiment for the purpose of determining whether camels could be used for transportation purposes in the United States. Never before or since that decade preceding the Civil War has the government been confronted with such serious problems as were caused by the territorial expansion of the late forties, and of these not the least serious were the difficulties of communication and of transportation on the far western frontiers. Even before the annexation of Texas, New Mexico and California it had been a difficult task to administer government on the outer frontier; after the Mexican war the troubles were multiplied. Immense territories had been added, the frontier was more than doubled in length and was more exposed and dangerous; much of the unsettled region was mountainous, or was dry and without grass and water for pack animals and cavalry horses. The settlements on the Pacific coast also had a frontier—an eastern frontier which had to be guarded as well as the western frontier on the other side of the mountains. And for political and military reasons it was necessary that communications between California and the rest of the United States be made shorter and safer. The experiences of the army officers, especially those of the Quartermaster's Department, during the Mexican war caused them to turn serious attention to the question of transportation. On account of the rough or desert character of much of the country it was not possible to make much use of horses and packmules. Railroads, it was thought, would not for years traverse any of this country, and would never open up all of it. A formidable danger to frontier settlements, to small army garrisons and camps, and to communication of any kind, lay in the attacks of the hostile Indians of this region who, on their swift ponies, could make sudden raids and escape capture by the foot soldiers or the small bodies of cavalry.[1]

That the camel would suit such conditions was the belief of several army officers and particularly of Jefferson Davis, who when a young man had served in the army on the western frontier and later had commanded a regiment in the war with Mexico. The camel could travel faster than a horse and carry heavier loads over rougher ground, could go without water for days at a time and could live upon the poorest

[1] See Reports of Secretary of War, 1853–7.

forage. It could also endure better than the horse or mule the extremes of heat and cold in this western region. The experience of other peoples had proved the value of the camel. In northern Africa and over the greater part of Asia the animal had always been the beast of burden—the most important agent of transportation. In climate and physical geography our western frontiers were similar to the regions which were the home of the camel.

Camels had been used in America, but not in large numbers. The Spaniards had imported them into Cuba and South America for use in transporting ore from the mines to the coast, but this experiment had not been a success. In 1701 some camels were brought to Virginia, but nothing more is known of them. In Jamaica, where the English tried them, the "chigger" or "chiqua," an insect which infested the feet of the negroes, got into the feet of the camels, rendering them unserviceable.[2]

The proposal to substitute camels for mules, horses and oxen in transporting supplies for the army was first made by Major George Hampton Crossman, a graduate of West Point, who was Zachary Taylor's quartermaster in the Seminole war. The difficulty of transporting supplies in Florida caused him to suggest that camels be introduced and used for that purpose. He made a study of the subject, and twenty years later was considered one of the authorities concerning camels.

Prominent among the officers who took an interest in the matter was Major Henry Constantine Wayne, a Georgian, who during and after the Mexican war, served in the Quartermaster's Department. He, with Senator Jefferson Davis, late colonel of the Mississippi Rifles, made extensive studies in regard to the different breeds of the animal, its habitat, the proper care of it, and its adaptability to the arid plains of Texas, New Mexico and California. Wayne, in 1848, made a formal recommendation to the War Department that camels be imported for experimental purposes, and Davis, who was on the military affairs committee, undertook to get an appropriation. In March, 1851, he proposed to insert in the army appropriation bill an amendment providing the sum of $30,000 for the purchase of fifty camels, the hire of ten Arabs, and other expenses. In support of his measure he made a speech reviewing the history of the camel as a servant of man and explaining the need for the animals in the west. There they would be valuable, he said, not only because of their burden-bearing capacity and their ability to live long without water and to eat scraggy bushes, but because of their greater speed. The dromedaries, or swift camels, could be used to mount cavalry and could carry small cannon, as had been done in Persia and in Egypt. Senator Ewing at first objected that the climate in the mountainous parts of the west was too cold for

[2] Leonard, "The Camel," pp. 1–18; Marsh, "The Camel," chap. 16.

the animal, but Davis convinced him that camels were useful in parts of Asia where the extremes of heat and cold were greater than in the west. Senator Rantoul objected that the proposition was extravagant and others that it was ludicrous. The appropriation was not made.[3]

A year later, when Davis had returned to Mississippi, Bissell, of Illinois, introduced into the House a bill carrying a $20,000 appropriation for the purchase of camels. Both Evans, of Maine, and Shields, of Ohio, who supported the measure, spoke of it as originating with Davis. The remarks made show that the War Department had considered the matter carefully and favored the measure. The house passed the camel bill but it was lost in the senate.[4]

By this time the public was becoming familiar with the proposal to import camels and numerous suggestions were made to the government. John Russell Bartlett, the author and ethnologist, who for three years (1850–1853) had worked on the southwestern boundary, was of the opinion that camels should be used in that region. George Robins Gliddon, the archeologist, who had lived in Egypt for twenty-three years, wrote a memorial to congress declaring that the project was feasible. Another eminent person, who was exerting himself to get the government to make the experiment, was George Perkins Marsh, the philologist and diplomat, who had lived in the Levant and who was acquainted with the camel in Turkey and Italy. To help the cause he delivered a lecture in 1854 at the Smithsonian Institution and also wrote a little book which was published in 1856: "The Camel, his Organization, Habits and Uses, considered with reference to his Introduction into the United States."[5] The general interest in the camel project caused the organization of "The American Camel Company," of New York, which proposed to import burden camels for use in the west. About 1857 the company landed one shipment in Texas, but nothing is known of further activities.

In 1853 Jefferson Davis returned to Washington as secretary of war and at once took up the question of importing and experimenting with camels. He had already made extensive researches into the history and habits of the camel when a member of the senate committee on military affairs. Now Major Wayne, of the Quartermaster's Department, and Lieutenant Beale and Captain Adams, of the Fort Yuma post, were directed to prepare information with reference to the use of camels on the western deserts. In his report at the end of the year[6]

[3] House Ex. Doc., No. 1, 33 Cong., 1 Sess., p. 24.

[4] *Cong. Globe*, 31 Cong., 2 Sess., March 3, 1851. See Marsh, chap. 17, and Leonard, p. 15, in regard to Napoleon's camel corps and Wayne's translation of Columbari's Zemboureks about the Persian dromedary artillery.

[5] *Cong. Globe*, 32 Cong., 1 Sess., August 28, 1852.

[6] Marsh, "The Camel," chap. 17, on Introduction into the United States, and chap. 17, on Military Uses of the Camel.

Davis made a strong recommendation to Congress in favor of an experiment. He went into details about the great extent of newly acquired territory, its lack of navigable streams and of good roads, and the absence of grass and water for long distances. With horses, mules and oxen long circuitous routes had to be followed; the cost of transportation alone in this region was for one year nearly half a million dollars; and Indians made attacks and escaped because they could not be followed into the deserts and mountains; moreover, the Pacific coast, 120 days distant, was defenseless and for that reason quicker and better transportation must be provided.

Congress refused to make the desired appropriation and in December, 1854, Davis renewed his request for money to make the experiment. When the army appropriation bill was reported it carried no appropriation for the purchase of camels, but Senator Shields of Illinois and some western representative secured the amount of $30,000 for this purpose. The bill became a law on March 3, 1855, and Davis at once proceeded to send for the animals.

The camels could be procured only from the Levant. The mission to the Orient was first offered to Major Crossman, who nearly twenty years before had first suggested the use of camels. He declined, and Davis sent Major Wayne and Lieutenant David D. Porter of the Navy. Wayne was to go to England and France to secure further information about the camel, and Porter was to take the storeship *Supply* to the Mediterranean and meet Wayne at Spezzia. Davis furnished Wayne with a digest of all that was known about the camel and his letters of instruction show that the secretary possessed full knowledge of the subject.

Wayne visited first the Zoological Gardens in England and reported that camels had been reared there under such conditions that he was certain of success in the United States. Next he went to Paris to consult with the French officers who had made use of camels in Algeria.[7] From the information secured he decided that the African camel would not succeed in America as well as the Asiatic. He adopted the following classification: The Bactrian was the large two-humped animal, the Arabian the one-humped, and the "dromedary" was merely a swift Arabian, not a burden camel. These were points then confused by naturalists.

Meanwhile Lieutenant Porter had gone ahead and inspected at Pisa the camel herd of the Duke of Tuscany. These were descendants from Egyptian stock and had been used in Italy for two hundred years. There were 250 of them, Porter wrote, and they performed the work of 1,000 horses—some of them carrying as much as 1,200 pounds at a load; but he considered them overworked and badly cared for.[8]

[7] See Marsh, chap. 17.

[8] See Leonard, p. 13.

After Wayne and Porter met at Spezzia they decided to get a camel at once in order to study its habits and to learn the proper treatment. They went in the *Supply* to Tunis, where Mohammed Bey gave them two animals which they hoisted on board, and proceeded to the Asiatic coasts, studying on the way the habits, ailments and care of the animals. Their observations were carefully reduced to writing and sent to Davis. The first stop after leaving Tunis was made at Smyrna, where they found fine burden camels, but no dromedaries such as Davis was anxious to get for chasing the Indians; at Salonica, the next stop, there were no camels—from both places the dromedaries had been taken for use in the Crimean war then going on. Davis had instructed Wayne and Porter to go to Persia to see about the Bactrians of that region, but at Salonica they found that the roads were closed by snow—it was now December—and that the country was in an unsettled condition. So after sending circulars to the English-speaking missionaries, consuls and business men in the Levant requesting information, the two officers sailed to Constantinople and thence went to the Crimea to see what was being done there with the camels. Wayne reported that the Bactrians seemed to be of little use because they were slow and because of their two humps, which made it difficult to fasten on the loads. But the one-humped Arabians were valuable; 3,000 were already in the Crimea and more were to be imported for the next campaign. The English officers who had used them in India were enthusiastic.

At Constantinople Wayne was disappointed in not getting a supply of both kinds of animals. All there were worthless or had the "itch." The Sultan sent far into the interior for good ones to give them, but Wayne, anxious to go to Egypt, did not wait for them to be brought to Constantinople.

The *Supply* sailed to Egypt and while Wayne went to Cairo to get permission to export dromedaries Porter remained at Alexandria looking over the market and making a lengthy report to Secretary Davis. He was now an enthusiast on the subject of camels. "I hope to see the day," he wrote, "when every Southern planter will be using the animal extensively." The education of Wayne and Porter progressed rapidly. They were soon expert camel traders. Animals at first palmed off on them as good they were now able to pronounce worthless. These they got rid of—two, for instance, they sold to a butcher in Constantinople for $44. Porter said "the good condition of these camels recommended them to a butcher of Constantinople, who bought them for purposes known only to himself." The natives now could not impose upon the ignorance of the American officers.

An amusing incident happened in Egypt. Wayne found it difficult to get permission to carry camels out of the country. He wanted twenty dromedaries; but could get permission to carry out only two. After protest this number was increased to four and later to five. Some-

what disgusted, Wayne started to leave Egypt, but the viceroy notified him that he would present six camels to the United States government. After delay the animals came. Porter after looking at them wrote an indignant letter refusing to accept the gift. They were "worthless and diseased," he said, and "I can not conscientiously receive them." The attempt of the Egyptian officials, he said "fraudulently to force a present on us" was a "discourtesy" to the United States which he would not tolerate. The viceroy laid the blame upon his servants and finally six good dromedaries were secured. Only three others were taken on board here, and the *Supply* sailed for Smyrna to complete the cargo.

The loading of the camels was done under Porter's supervision. Before leaving the United States he had prepared a "camel deck" or stable on the lower deck and had cut through the upper deck to secure a constant supply of fresh air for the animals. To get them on board he constructed a long flat-bottomed boat which could be run ashore. On this was a strong car with wheels which could be pulled out on land to receive the camels who often had to be dragged into it, and then the car was rolled back on the boat. From the boat the car holding the camel was hoisted into the ship and let down to the "camel deck."

While in Alexandria waiting for the viceroy to act, Mr. G. H. Heap, an American who had lived in Tunis and who accompanied the expedition, was sent on ahead to purchase other camels and equipments. When the *Supply* reached Smyrna, on January 30, 1856, Heap had the camels, saddles and other supplies ready. They were taken on board and on February 15 the *Supply* was turned toward America. The cargo consisted of thirty-three camels: nine dromedaries (Arabians) from Egypt; twenty Arabian burden camels; one young Arabian camel; two Bactrian (two humped) males; one Booghdee or Tuilu, the offspring of a Bactrian male and an Arabian female, having one hump.

Before leaving Smyrna the females that were not already with young were covered by the males, since it was the rutting season, and it was desired to increase the herd as fast as possible. To take care of them four Americans, two Turks and three Arabs were brought along—all under the supervision of Albert Ray, an army wagon master.

During the return trip, which lasted three months, the weather was rough. Wayne and Porter had been requested by Davis to stop at the Canaries[9] to see the camels there, but they were prevented by heavy winds. Wayne occupied himself in writing a long report to the secretary of war and in translating French works relating to camels. He wrote Davis that the information furnished by the letter had been generally accurate. The report gave a detailed history of the camel, an

[9] See Leonard, p. 13.

account of the different breeds, their habits and usefulness, the nature of their diseases, the location of the best stock, the cost, the proper food and the methods of transportation. One of the papers translated was by Linant Bey, a French engineer in the Egyptian service, on "The Egyptian Dromedary"; one by General J. L. Carbuccia on "The Use of the Camel in Algiers." A paper by Colonel F. Columbari entitled "The Zemboureks, or the Dromedary Field Artillery of the Persian Army," had been translated and illustrated by Wayne in 1854.

During the voyage the animals were under the direct supervision of Lieutenant Porter, who interested himself in the minutest details. On the camel deck he posted detailed regulations to be followed in the care of the camels. A "journal of the camel deck" was kept, and in it every day wagon master Ray made note of every item of interest concerning the animals, their ailments, feed, appetites, when they were rubbed, curried, oiled, salted, etc. Some of the names are given: Said, Ayesha, Gourmal, Ibrim, etc. The first young camel born on board the ship was dubbed "Uncle Sam" and was trained by one of the Turks as a Pehlevan, or wrestler. Four of the grown camels were Pehlevans. Camel fighting was as much an oriental amusement as horse racing was a Kentucky sport, and Porter thought that the Americans might in time come to like camel contests.

When the weather was stormy and the ship unsteady there was danger of the animals falling on the smooth deck and injuring themselves. To prevent this Porter fashioned a sort of harness for each one and in rough weather made them kneel and strapped them to the deck. Once they were so strapped down for seventy-two hours.

During the voyage six calves were born. Of these only two lived; the others were probably killed by the ministrations of a quack Turkish camel doctor on board. Porter took care of the young camels as if they had been children, and gravely wrote to Davis about their diet, appetite, health, etc. Soon he was a better camel doctor than the Turk and the latter was superseded. To the secretary of war Porter sent some of the Turk's prescriptions: For a cold give the camel a piece of cheese; for swollen legs, tea and gunpowder; cauterize frequently for skin diseases; and for other complaints tickle the camel's nose with a chameleon's tail, or boil a young sheep in molasses and administer half of the mixture while hot. No wonder Porter was certain that Americans could manage camels better than the Asiatics.

At Kingston, Jamaica, a stop was made and great numbers of visitors came on board to see the camels—in one day 4,000 came. But here the camels suffered so much from heat that departure was hastened.

On April 29, 1856, the store ship reached Pass Cavallo, off Indianola, where, it was planned, the camels were to be landed. But the sea was so rough that the transfer to lighters could not be made. Porter then sailed to the Balize, the southwestern mouth of the Mississippi

River, and there on May 10 he transferred his cargo to the steamer *Fashion* under Major Wayne. Four days later Wayne landed the cargo at Powder Point, three miles below Indianola. The animals were in good condition notwithstanding the long confinement—one of them had been on board nine months. "On being landed, and feeling once again the solid earth beneath them," Porter wrote, "they became excited to an almost uncontrollable degree, rearing, kicking, crying out, breaking halters, tearing up pickets, and by other fantastic tricks demonstrating their enjoyment of the 'liberty of the soil.' Some of the males becoming even pugnacious in their excitement, were with difficulty restrained from attacking each other." The Texans were greatly interested in the camels and Porter wrote later to Davis that "perhaps the love of amusements may render the importation of camels in Texas popular if their utility does not recommend them." He meant that the Texans might possibly take to camel fighting.[10]

Less than one third of the appropriation had been expended and Davis determined to send at once for a second cargo of camels. Wayne was again offered command of the vessel, but he preferred to remain in Texas to conduct the experiment. Major Crossman also declined to go. Finally Porter and Heap were sent. Before leaving Porter carried to Davis the "Camel Deck Journal," his letters rejecting the camels offered by the viceroy of Egypt, and some drawings of camels in harness made by Mr. Heap. Porter arrived at Smyrna in November, 1856, where he found that Heap, who had gone on ahead, had collected a number of young camels. The six dromedaries presented by the Sultan had been sent to Smyrna and these with the others were taken on board. On November 14 the *Supply* again set sail for Texas. On board were forty-four animals: Two Bactrian males; three Arabian males; one Tuilu, cross-bred, male; one Tuilu, cross-bred, female; thirty-seven Arabian females.

The second voyage homeward lasted eighty-eight days and was rougher than the first. For thirteen days at one time the camels were strapped to the deck. But only three died during this voyage and Porter turned over to Captain Van Bockelen, quartermaster at Indianola, forty-one animals in good condition. There were now seventy in the herd, five of the first number having died since reaching Texas.

Meanwhile, during the summer of 1856, Wayne had been testing the value of the camel as a burden bearer. Certain of success, he wanted to breed camels until the herd was large, but Davis wanted to ascertain first whether they would be useful. For a few days the animals rested at Indianola. The Texans refused to believe in their burden bearing capacity, so one day Major Wayne had two bales of hay, weighing 314 pounds each, loaded on one of the males; the spectators were sure that

[10] The documents in regard to the expedition are in Sen. Ex. Doc., No. 62, 34 Cong., 3 Sess. See also Marsh, p. 210.

he could not rise; Wayne then put two more bales on, making 1,256 pounds in all. The camel rose easily and walked off. Wayne wrote to Davis that it quite convinced the skeptical and that it caused a Texan poet to break into verse in the *Indianola Bulletin*. Later Miss Mary A. Shirkey, of Victoria, Texas, knitted from camel's hair a pair of socks for President Pierce. Major Wayne forwarded them through the secretary of war.[11]

During the latter part of May the camels were marched by easy stages to San Antonio where they were kept nearly a month and then removed to Val Verde (Green Valley)—a military post sixty miles southwest of San Antonio. Here at Camp Verde, as it was called, the permanent camel post was located. In September Wayne sent camels and horses to San Antonio for supplies. The camels easily brought 600 pounds each; six of them carrying as much as twelve horses could haul in wagons and in forty-two hours less time; the camels made the sixty miles in two days and six hours, while the horses required over four days. Later tests, made in November and December, 1856, showed that camels could easily climb mountain trails where wagons could not go, and that on muddy roads over which horses could not draw wagons, the camels traveled without fatigue. Only on slippery slopes were they troubled, and at the crossing of streams. Not being accustomed to fording, they had to be driven in by throwing water in their faces. At the end of 1856 Davis reported that in his opinion the experiment was a success.[12]

Davis left the War Department in March, 1857, and was succeeded by John B. Floyd. Wayne was transferred to Washington and the camels were left under the supervision of Captain J. N. Palmer, at Campe Verde. In 1858 the "Société imperiale Zoologique d'acclimatation" of Paris, awarded to Major Wayne a first class gold medal for the successful introduction and acclimation of the camel in the United States. Secretary Floyd was convinced of the usefulness of camels on the western plains, and in his second report, December, 1858, he recommended that 1,000 be purchased. This recommendation was repeated in 1859 and in 1860, but Congress paid no attention to the matter.[13]

After 1857 some of the camels were sent to the army posts at El Paso and Bowie. They were disliked by the army hostlers; the Arabian and Turkish caretakers were regarded with contempt, and it was difficult to get the American hostlers and wagon masters to help in the experiments. The horses objected to the smell of the camels when stabled or picketed near them and the hostlers sometimes turned the camels loose to get rid of them. However, during the four years before

[11] Sen. Ex. Doc., No. 62, 34 Cong., 3 Sess., p. 148–63. *Harper's Magazine*, October, 1857.

[12] Sen. Ex. Doc., No. 5, 34 Cong., 3 Sess., p. 22.

[13] Sen. Ex. Doc., No. 2, 36 Cong., 1 Sess.

the outbreak of the civil war some interesting and successful attempts were made to use the "ship of the desert" for military transportation purposes. The first lengthy expedition was made by Lieutenant Edward F. Beale, who on September 1 set out to make a wagon road from Fort Defiance, New Mexico, to California. Camels, as well as mules, were used by the road-making party. The work lasted forty-eight days. Beale reported that the camels had been subjected to the severest tests and had failed in no instance; that they even learned to swim rivers. Beale considered that one of them was worth four good mules. From 1857 to 1861 Beale with twenty camels was occupied in exploring the unknown regions of the southwest. He found that the camels could do successfully all that was required of them. By 1861 his herd of twenty had increased to twenty-eight.[14]

Other trials of the camels were made in 1859 by Major D. H. Vinton, who used twenty-four of them in carrying burdens for a surveying party.[15] From May to August, 1859, Lieutenant Edward L. Hartz was in charge of the camel herd. Hartz sent to the War Department a full journal of an exploring expedition in which camels and mules were used. His verdict was not quite so enthusiastic as those of Wayne and Beale, but he pronounced the experiment a success. The camels were inferior to mules, he said, on slippery surfaces; they were not as good climbers as mules, but they were much swifter on level, rocky or sandy ground; it was difficult to keep the loads on the camels and frequent stops had to be made to replace the saddles, which could not be properly fastened by inexperienced packers. It was his belief that the female camel was better than the male; that the camels really preferred bushes, dry shrubs and grasses to grazing grasses; that they could go without water for more than two days and not suffer. All in all, he concluded, the camel was much superior to the mule.[16]

The success of the War Department tests caused other importations. In 1858 a British vessel brought over two cargoes of camels for a Mrs. Watson, who lived near Houston, Texas. Arab caretakers were employed and F. R. Lubbock, later governor of Texas, was put in charge of them. He says that they were healthy, and useful, but that they created too much sensation when they went into Houston or traveled about the country.[17]

There is a tradition that ten animals were brought to New York in 1857; of these two survived and were sent to Nevada, where by 1875 their offspring numbered ninety-five.[18]

In 1861 a San Francisco company imported twenty Bactrians (two-

[14] Circular No. 53, Bureau of Animal Industry, 1903.
[15] Sen. Ex. Doc., No. 2, 36 Cong., 1 Sess., p. 422.
[16] Sen. Ex. Doc., No. 2, 36 Cong., 1 Sess., pp. 425–41.
[17] Lubbock, "Six Decades in Texas," 1900, p. 238.
[18] Leonard, pp. 14, 123.

humped) camels from the highlands of Asia for use in transporting salt from Esmeralda County, Nevada, to the Washoe Silver Mill, a distance of two hundred miles. The discovery of a nearer supply of salt left the camels without regular occupation. Some were used near Virginia City as late as 1876 to carry cord-wood.[19]

When the civil war began the government camels were scattered. Some were at Camp Verde, Lieutenant Beale's herd of twenty-eight was in California, and others at various posts in Texas. Beale, whom in 1861 Lincoln had appointed surveyor-general of California, proposed to Stanton that the government animals, which were scattered about in California doing nothing, should be turned over to him for use in carrying supplies and in making explorations. His request was not granted. In 1863 an attempt was made to use the camels in carrying the mails between New Mexico and California, but the officers in charge of the mails, knowing nothing of camels, objected and they were not used. In 1864 the herd, now numbering thirty-five, was sold to Samuel McLaughlin, who disposed of them later to circuses and zoological gardens.[20]

The herds at Camp Verde and other places in Texas were constantly used by the army quartermasters up to 1861. The ugly animals were well known sights in the towns near Camp Verde and between San Antonio and the gulf coast. But horses were often frightened by them and people began to regard them as a nuisance; Brownsville had an ordinance forbidding them on the streets. When the United States forces were withdrawn from Texas in 1861, the camels fell into the hands of the Confederates who made little use of them and spent little care upon them. They were turned loose to graze and some wandered away. Three of them were caught in Arkansas by union forces and in 1863 they were sold in Iowa at auction. Others found their way into Mexico. A few were used by the Confederate Post Office Department. At the close of the civil war the animals at the Camp Verde station, numbering sixty-six, were advertised for sale. Only three bids were received, one for $5 each, one for $10 each, and one for $31 each. So on March 8, 1866, the quartermaster in New Orleans sold to Colonel Bethel Coopwood the camels then in Texas. Colonel Coopwood carried them to Mexico and disposed of them to traveling circuses.

The stray camels were heard from occasionally—stampeding horses and ravaging fields. The Indians killed and ate some. The Navajos, it is said, once tied a Mexican shepherd to a camel's back and turned the animal loose. During the seventies soldiers in the southwest reported seeing strange camels.[21] Colonel Philip Reade writes that in July, 1875, he saw a herd of wild camels near Oatman's Flat, on the

[19] Circular No. 53, Bureau of Animal Industry.

[20] Circular No. 53, Bureau of Animal Industry.

[21] *Taylor-Trotwood Magazine*, June, 1907.

Gila River. One of the government camels was living a few years ago in the public parks of the City of Mexico.

The attempt to make use of camels might have succeeded under different conditions. Davis, the strongest advocate of the use of the camel, went out of the war office just as the experiment promised success. Major Wayne, who alone of army officers had full theoretical and practical knowledge of camels, was transferred to office work at Washington, and Beale, who later accumulated considerable experience, was not encouraged by the War Department officials. The army teamsters and most of the officers outside of the Quartermaster's Department, took no interest in the matter and some opposed the experiment; the members of Congress were too deeply engaged in sectional controversies to care much about transportation problems in New Mexico. The Civil War afterward occupied the attention of those in authority while the herds were neglected, and the fact that Jefferson Davis had inaugurated the experiment was, in the opinion of many, enough to condemn it. After the war the rapid development of railroads solved many of the problems that seemed so serious in the fifties.

And yet had Wayne, Beale and Hartz been given ten years of favorable conditions, it is probable that camels would now be used as beasts of burden in some parts of the south and west, for conditions still exist in that section under which the camel would be useful.

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RAILROADS AND THE SMOKE NUISANCE

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AMERICAN CIVIC ASSOCIATION

IT is estimated, so says the *Scientific American*, that 150,000,000 tons of coal are used annually by the railways of the United States, out of which but 7,500,000 tons are used in drawing the trains, while 142,500,000 tons go up the smoke-stack. And a recent English writer, John W. Graham, declares that a locomotive uses 3½ tons of coal per day on an average, and scatters the smoke of 36 pounds of coal over every mile on fast trains.

These two statements give us some conception of the appalling extent of the smoke nuisance so far as the railroads are concerned, and fill us with amazement and incredulity. How is it possible that railroads which are run for the profit of the stockholders, or at least are presumably so run if we may credit the statements made before legislative committees by their representatives, can permit so great a source of waste to have gone so long unchecked? Why is it that so many railroad officials have opposed in every way possible efforts to reduce the evil?

In Boston, according to one observer who has carefully studied the situation, the New York Central and Hudson River Railroad Company, through its officials, curtly refuses to discuss the matter or to make any change in its smoke-producing methods, and he made substantially the same charge against the New York, New Haven and Hartford road. Z. A. Willard in an open letter to the Boston *Herald* (on March 7 last) declared that

> Having been deeply interested for many months past in an endeavor to prevent or mitigate the smoke nuisance resulting from the use of soft coal on locomotives engaged in suburban traffic, I was called in consultation by the Boston management of the New York Central and Hudson River Railroad and informed that under no circumstances would this company make any change involving expense. Economy was now the ruling consideration.
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> When informed that the nuisance could be entirely obviated by the use of coke—coke being no more expensive than soft coal—the answer was the same, "Economy."
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> When reminded that eighteen locomotives had been constructed for the suburban traffic designed especially for burning anthracite, the answer was the same, "Anthracite costs money, and would not be considered." So that if so small a matter as the prevention of annoying smoke will not be considered by the New York Central authorities, tunnels, electricity, etc., may as well be relegated to the limbo of the impossible.

A correspondent of the Providence *Tribune* registered strong protest, as late as April 26, against the nuisance which the New York and New Haven Railroad Company is maintaining in the Elmwood district of the city. All day long the section is shrouded in a pall of dense, evil-smelling smoke and cinders, vomited forth by locomotives. The chief offenders are the short suburban trains, the expresses and heavy freights not causing half the bother made by the little fellows.

In and around New York City the aid of the Public Utility Commission had to be invoked to abate the nuisances maintained by these two roads in the matter of smoke. The New York Central in January last was ordered, "directed and required to cease and desist from the use of soft coal on any of the engines used by it on its New York and Putnam Division while within the corporate limits of the city and to institute and continue the use of hard coal on its engines."

The New York, New Haven and Hartford road was "directed and required to cease and desist from suffering or permitting in any manner the emission of black smoke from the stacks of the engines in use on the company's lines" while in the Harlem River Terminal Yard, and moreover it was ordered to cover all soft coal fires in engines with coke and to continually feed and replenish them with coke while the engines are in the yard.

Here we have the striking spectacle of two railroads being compelled by law to do certain things (and doing them, too) at one terminus, which they declare at the other end they can not do on the score of economy. At the one end (New York) there is a strong and effective law designed to protect the interests of the public; at the other, there is no such law, for, alas! the Massachusetts Railroad Commission, admirable though it is in many respects, finds that it is powerless to suppress the smoke nuisance.

The most striking defense of the railroad smoke nuisance, however, comes from the president of the Erie Railroad, one Frank D. Underwood, who is on record in a letter to Monsignor Sheppard, of Jersey City, rector of the Roman Catholic Church of St. Michael, that

There is a good deal of nonsense about coal smoke being injurious. There is no healthier class of people in the world than those employed about soft coal mines, and they are begrimed from head to foot the majority of their lives.

Permit me to state that men occupying leading positions, such as yours, are expected to allay senseless clamor against corporations instead of adding fuel to it, and it is hoped we may have the influence of your valuable efforts in our direction rather than adversely. Many of the people who gain a livelihood through the Erie Railroad I have no doubt are parishioners of yours and you should be able to ascertain from them whether there is more black smoke than is absolutely necessary in the operation of a railroad.

In conclusion, the Erie Railroad was chartered fifty years ago, and it is identical with other interests in that it pays taxes. Is not something due to it, therefore? And was it not on the ground in advance of most of its complain-

ants? It is a penalty people pay for prosperity. The smoke-laden air of every city is but a testimonial of the general prosperity of the country. No smoke and rural stagnation is the rule—pleasant to live in, but not conducive to general prosperity.

All of which is respectfully submitted by the president in behalf of the board of directors.

Here then we have what we may appropriately call the official defense of black smoke! It is healthy; it is inevitable; it is a concomitant of prosperity and those who make it pay taxes! Surely a formidable argument, hardly requiring, however, a reply from the reverend Monsignor. Still parts of his reply are so apt as to justify quoting. After declaring that he had not asserted that the Erie engines could be run without smoke while consuming coal, he declared that the use of bituminous coal should not be tolerated in our cities, as it is not tolerated in New York, which had its

smoke problem and solved it as New Jersey should do; of course I need not tell you that the elevated roads running through the great arteries of the metropolis, and the Grand Central were to my mind a species of "railroad traffic" and therefore my comparison is not odious.

I have not said that any, or all, railroads are a nuisance, on the contrary, I consider them one of the greatest blessings, but I do most persistently assert that they are capable of committing nuisances, and in this particular instance under discussion are now injuring, as they always do, where such abuses are patiently borne, our property, and our homes.

I believe railroads do pay taxes. I do not know a great deal about this question, never having given it much consideration, but I do read occasionally that the whole machinery of the city and state have to be put in motion to collect the taxes levied.

From what you say of the healthy condition of the bituminous coal fields, which is not relevant to the issue, the attention of our leading physicians should be called to it. As health resorts these fields might enter into competition with the seashore and the Adirondacks.

No evidence is needed in any city of considerable size as to the existence of the smoke nuisance and of the part which the railroads play in maintaining it. There is an abundance of it on every hand; all too obvious, all too persistent. The encouraging feature of the situation, however, is the existence of a wide-spread and intelligent effort on the part of alert and progressive railroad officials to meet the situation and abate the nuisance. Largely, no doubt, because of the financial considerations, but in some instances because of a growing conviction that it behooves them to give heed to legitimate public demands, and because they are awakening to the fact that it is the wisest policy.

The recent orders of the Pennsylvania Railroad to its engineers and firemen may be said to be almost epoch-making in their importance and significance. This great corporation, in order to secure greater economy in the use of coal and to reduce the smoke nuisance, has inau-

gurated a special campaign of education among its engineers and firemen. A general order has been issued to the effect that "smoke means waste and must be avoided."

Five assistant road foremen of engines are now at work instructing firemen how to reduce the quantity of smoke emitted by engines. It is estimated that ten pounds of coal were required last year to generate steam necessary to haul one freight car one mile. The safety valve of an engine, if left open one minute, will lose an equal amount of steam. The Pennsylvania Railroad last year hauled 1,248,300 freight cars one mile and its coal bill was $10,000,000. Therefore, the savings of one per cent. by more efficient handling of coal will result in a saving to the company of $100,000 annually.

Under eighteen separate heads, thorough and minute instructions in the general order issued, the company has gone into the elementals of locomotive firing. Coal no larger than three inches thick may be used; tenders must not be overloaded so that coal is dropped along the track; grates and ash pans must be watched closely, in order to decrease the number of repairs on engines.

The example thus set by the Pennsylvania Railroad is bound to be of far reaching influence. As the Chicago *Record Herald* puts the case

> The argument should appeal to every smoke producer, for it would seem now that it had time to penetrate the smokiest kind of a brain. At any rate, its soundness has been demonstrated beyond question many times, and examples such as that of this great railroad corporation should add greatly to its force. But it is curious how long it has taken to convince smokers that the smoke actually meant waste, and how stubborn some of them are still in spite of all the teaching by precept and example. Conditions prove that they would never learn except under compulsion, under the determined attempts of the public authorities to abate a nuisance and to protect the thousands against the stupid selfishness and indifference of the law.

Another view of the attitude of the corporation was taken at the Providence meeting of the American Civic Association by the superintendent of motive power on the New York, New Haven and Hartford Railroad, Mr. George W. Welden, declaring that

> As a general proposition, railroad companies are assumed, by the rank and file, to take only such interest in the question of smoke elimination on locomotives as they are actually compelled to through the clamor of the public and the penalties imposed or prescribed by ordinances and enforced by the courts. If the above assumption were really true, then railroad operation in general could be properly classed as the most miserably managed business in the world. The New York, New Haven and Hartford Railroad, while constituting but a small percentage of the railroad mileage of the United States, and necessarily consuming but a small proportion of the total fuel burned on all railroads, could save annually for its treasury approximately $600,000 if some good Samaritan would suggest a method or device by means of which the black smoke and unconsumed gases which now escape from the smoke stacks of our locomotives could be completely burned and used as effective fuel. Second to

the above-mentioned saving would be that accruing to the treasury because of the absence of the necessity of defending damage cases before the courts, involving, as they do, hundreds of thousands of dollars, and, naturally, the saving of the very large sums paid annually in fines. In addition to this, many incidental savings would be made in the form of less labor and time required to clean all classes of equipment both inside and out, including an increased life for the varnish on all classes of equipment. Coupled with this would be a decidely improved appearance.

Whether moved to do so by force of public opinion, by lawsuits, by economic considerations, or by the strong arm of the law as in the New York cases already cited, the railroads of the country are moving in the matter and moving in the right direction at a fairly rapid degree of progress.

The American Master Mechanics, in their latest session at Atlantic City, have declared that it is possible to stop the nuisance. Expert firing and proper stoking are the most efficient means. These master mechanics, who are mostly connected with the railroads, are of the opinion that smoke-consuming devices are of assistance in keeping down the flow of black soot that has resulted in the passage of city and state laws against use of cheap, soft coal as fuel, but the firing is of so much more importance in the work that recommendations will be made to sacrifice cost of expensive devices of the kind in favor of higher paid and more expert firemen.

This opinion is unquestionably shared by the Pennsylvania Railroad, for their most recent instructions are in harmony with this principle, and when their Cincinnati superintendent was asked if the company's firemen were arrested for violations of the local ordinances would the companies pay the fine, he said:

No. The men would have to pay that themselves. We favor your getting after the men. We have suspended some firemen for making too much smoke. If they throw one shovelful of coal into the furnace at a time and do it frequently, they will not cause so much smoke. But instead of doing that, they throw in ten shovelfuls, and then take a rest. We have pleaded in vain with many to stoke in the right manner. Perhaps better results could be obtained if the league's officers went after them rigidly and called them to time.

Another student of the subject (Z. A. Willard, of Boston) has also reached the decided conclusion that the fireman on the locomotive is largely responsible for the nuisance. The firing of any furnace, locomotive or stationary, although generally considered a perfectly simple matter, is, on the contrary, a science requiring the services of a conscientious and experienced fireman, an opinion which is supported by Mr. Angus Sinclair, president of the Society of Locomotive Engineers, who, in his book on locomotive firing, gives his experience with two firemen on the same locomotive, running the same distance, on two successive days. The first fireman, in one hour and fifty-five minutes,

the time occupied in the run, used eight thousand pounds of soft coal, making steam with difficulty, and filling the atmosphere with smoke. The next day, another fireman, with the same engine, running the same distance, used forty-five hundred pounds of the same coal, with plenty of steam and no smoke. The result was a saving of 43¾ per cent. of coal, and no annoyance from smoke. As the first condition is pretty nearly universal on roads where soft coal is used, the loss to the roads from ignorance or carelessness must be enormous.

Electrification is another method by which the smoke nuisance is to be abated.

On and after July 1 there are to be no more steam trains run into the Grand Central Station in New York. Electrification of the New York Central terminal, according to the New York papers, has progressed far enough to make this change practicable, and the order to run only electric trains into the big depot went into effect on July 1. This move does away with the nuisance of smoke, steam and gas in the Park Avenue tunnel. The new order applies also to the New Haven Railroad trains.

The Scientific American quotes some statistics from a paper read by W. S. Murray at a recent meeting of the American Institute of Electrical Engineers, which confirm and strengthen the testimony furnished by W. J. Wilgus to the American Society of Civil Engineers. They clearly show that electrification pays when tried.

In Mr. Murray's paper it is shown that to haul the express, local and freight trains of the New York division of the New Haven railroad now involves the consumption of 57,000, 58,000 and 188,000 tons of coal, respectively, whereas when the whole division is operated electrically the amount of coal burned for the respective classes of service will be 30,000, 28,000 and 139,000 tons.

In like manner the figures of cost and repairs of twenty steam freight and passenger locomotives on the New Haven road are given. They show an expense of 8.1 cents per locomotive mile for freight engines and 5.6 cents for passenger ones. The total mileage of the locomotives per year is easily ascertained and therefore the total expense for maintenance and repairs of locomotive service. The figures are placed at $316,962 per annum. Available figures for electric locomotive repairs show two cents per locomotive mile. Counting the same number of miles and the same number of engines, the total expense would show a saving of $196,038 per annum.

In brief, experimentation in the east has proved that electrification pays both in a great saving in the cost of the coal used and in the cost of maintenance and repairs. If it pays in the neighborhood of New York it will pay, as the Chicago *Tribune* maintains, in Chicago. It is electrification, not improved smoke consuming devices, that Chicago

wants the railroads to experiment with. The head of the Illinois Central, however, J. T. Harahan, seems to think otherwise and in a long letter urges first that the art of electrification is in its infancy, and, secondly, that the experiments in the east have developed many difficulties.

Possibly if Illinois had a public utilities commission, like that of New York, President Harahan might take a somewhat different view of the situation, one more like that of the New York Central, although the economic argument ought to appeal to President Harahan and he ought not to allow the Pennsylvania Railroad to outdo him in the race for dividends or compliance with reasonable public demands. As one commentator on his position put it, "The financial question has two sides to it. The cost of electrification will be heavy. The cost of the smoke and noise nuisance to the community is a hundred fold heavier," and it could have pointed out that whatever makes for the prosperity and uplift of a community eventually makes for the benefit of the railroad.

According to Smoke Inspector Krause, of Cleveland, the smoke from railroads in that city has, within the past few years, been greatly reduced through the care that has been taken by the railroad officials. The inspector has one man who gives his entire time to this side of the work. Their records are sent to the offices of the officials and the crews are called in and reprimanded if the records show that they have been at fault. Some of the men have been discharged for not exercising proper care in this respect. The New York, New Haven and Hartford Railroad assumes a similar attitude. Recently it caused to be published this discipline bulletin:

> An engineman and fireman have been disciplined for permitting their engine to emit black smoke while standing in a passenger terminal some thirty minutes before leaving time, in violation of the rules of ordinary intelligence as well as those of the railroad company, and in disobedience of chapter 983 of the public laws of the state of Rhode Island,—J. A. Dodge, Superintendent.

Z. A. Willard, already several times quoted, declares as a result of his investigation that the use of coke will entirely eliminate the smoke evil, as it is free of smoke, soot and dust, and can be used on locomotives as at present constituted. The Boston and Maine Railroad is daily using seven hundred tons of Otto coke (produced by the gas works at Everett, Massachusetts) on all their short lines, and pronounces it perfectly satisfactory both to patrons of the road and residents along the lines, in avoiding smoke.

Some of the western roads use petroleum. For instance, the Mexican Central burns 4,000 barrels a day, at a cost of $1.10 a barrel. The Southern Pacific is also introducing oil-burning engines, especially for the switch engines. Hard coal is also used on the roads, which have

convenient access to the anthracite regions, like the Lackawanna and the Reading; but other companies maintain that the cost of the coal and of changing their boilers prohibits the introduction of anthracite.

There is always some reason for not doing the obviously proper thing!

It is to be hoped, however, that the despatch of June 17 from Chicago is well founded. It reads to the effect that

> The general managers of railroads centering in Chicago claim that a determined campaign has been begun to secure greater economy in the use of coal, and at the same time reduce the smoke nuisance. Perhaps the most virtuous exponent of fuel economy is the Pennsylvania, the management of which has just started a campaign of education among its firemen.

To sum up: The elimination of the smoke nuisance, so far as the railroads are concerned, is feasible. Primarily it is a matter of proper firing and the use of the right sort of materials. The railroad officials are considering the question from various standpoints; some with a sincere desire to do all that possibly can be done as quickly as possible; others as rapidly as they are forced to do it by the law and by a militant public opinion; and a rear guard of hold-backs who are still closing their eyes to the obviously inevitable. These men will some day be disagreeably awakened, for the public is awakening on the subject and it expects everybody else to be.

ACCOUNT OF A TRIP IN SOUTHERNMOST JAPAN, WITH EARLY RECORDS OF ITS DISCOVERY

By Dr. ROBERT VAN VLECK ANDERSON
WASHINGTON, D. C.

ON one of the early days of May, 1905, three of us—a Japanese friend, my brother and I—were trudging through long avenues of pine trees and crossing the upland border line between the provinces of Hiuga and Osumi in southern Kiushiu and southern Japan. Kiushiu, the farthest south of the four main islands of Japan, is an exceptionally interesting and picturesque country, and perhaps the finest member of the archipelago. At this time we were traversing it diagonally from the open shore of the Pacific Ocean on the east to the bay and city of Kagoshima that mark the island's southern extremity. This is far from the center of the empire and the region of foreign traffic, and as yet there was no railway leading thither. The country paths are seldom trodden by foreigners, and the towns and villages are rarely afforded the amusement of a stranger's advent.

The rain was continuous, at times bringing such a downpour that it seemed to bid fair to flatten every object in the landscape. One who lives much out-of-doors in Japan must be reconciled to the coming of rain at all times, so we walked on gayly through it all, until the end of each day brought us to some inn where the night could be spent. As we neared our destination, the way followed torrents muddy with a burden of silt derived from the hills of volcanic ash and other volcanic rocks around about, and among green unterraced hills that reminded us of the limitless smooth slopes of home in America, so unlike were they to the usual terraced, stone-walled and rice-grown hills with forested tops that one knows throughout Japan. Finally we crossed over the axis of the island, the main divide, whence precipitous volcanic slopes led down through the rain-mist to the bay and islands that we could not see. Neither could we see the great smoking volcano Kirishima-yama, of which days before we had caught a glimpse from far in the north in the vicinity of Aso-san, and which we were later to view from southward on finer days.

After descending from the mountains and skirting the bay through extended ill-smelling fishing villages populous with staring people, we reached Kagoshima, the city of gardens and rich semi-tropical growth, the great port of the south. Here one looks down from one's balcony upon whole streets of shipping agencies, where hang great black and white placards of Chinese characters advertising dates of departure

that are never kept. Here there is a beauty in the landscape and a spirit of liveliness in the people that invites one to stay, and an invitation in the bay and boats to go adventuring southward to the little-known Liu Kiu Islands and Formosa, from relations with which this most charming of Japanese cities acquires much of its character. And here one is in the heart of the old province of Satsuma, famed for its porcelain of centuries, and its heroes, and its influence on the history of the empire from the earliest day to the very present.

During most of our stay a warm rain was flooding down over the city, interfering with the manufacture of "ancient" Satsuma ware, and hindering the departure of all steamers, which seldom go when it rains and thus give their crews and passengers the enjoyment of furloughs much of the time. It was entertaining to sit in kimono on the balcony outside of the paper windows and look down on the scene in the streets, at the constant flow of people walking with bare feet and bare legs along the muddy ways under brown oil-paper umbrellas; at the shoulder-borne baskets heaped with yellow "biwa," or loquats, with chrysanthemums and lilies; at the wide bamboo rain hats from under which rang out the musical cries and songs of men and women, basket carriers, venders of fish just out of the water, turnips just out of the ground, young bamboo sprouts that have grown over night and will be eaten for dinner, fruits, cakes and flowers to decorate the shrines.

A few days more brought out the sun and the full plant life of the height of spring, and all the clearness of outline and symmetry of the island-volcano Sakura-jima, which springs from a bay rivaling that of Naples in the loveliness of its water and surroundings. And it was rather to my disappointment that, with the coming of good weather, the little boat which we had been waiting to take to the islands farther south finally made up its mind to leave for Tanegashima.

This island lies south of Japan in latitude 30° 30′, and is separated from Kiushiu by the Van Diemen Strait. It is long and low and narrow, trending northeast, its length being thirty-six miles and greatest width seven. It is composed of highly tilted strata of Tertiary age. Its people are Japanese, and as far as known it has always belonged to Japan, being in every way more closely related to that country than to the more southern or Liu Kiu islands that form a long curving chain down to Formosa.

Tanegashima was the first portion of Japan to be discovered by Europeans centuries ago, and it was here that the Japanese first became acquainted with members of that other race. With the foreigners came a knowledge of firearms, which spread from this island to the rest of the empire. For this reason Tanegashima was the name formerly applied to all firearms, and to the present day some pistols are still so called.

To-day the island is not greatly changed from its condition at the time when the first Europeans came to its coast. Few foreigners have been there since, and on going there one in a measure reexperiences the impressions that must have come to those early navigators, and presents a somewhat similar appearance to the present inhabitants as did those first foreigners to the earlier generation. The people live in a world of their own, and are connected with the mainland—a mainland that is itself an island—merely by a little one-hundred-ton steamer that runs with a reliable lack of regularity.

The sixty-mile ride out to sea from Kagoshima on this steamer was to be an all-night one. We purchased the best accommodations to be had and were off down the bay in the evening. The process on boarding a boat in Japan, after taking a sampan or scow out from the landing to where the boat is moored, is first to see to the safe storage of one's heavy baggage, and then, taking off one's shoes, and bowing the head, to enter the little door of the cabin that serves as sitting-room, dining and bedroom for those of the class to which one's ticket entitles him. Bowing the head is in this case not an act of politeness but merely of practical utility in preserving one's cranium and temper, and a practise that a foreigner in Japan learns to remember after many daily lessons. After one has entered, the act of kneeling and bowing to the floor as a greeting to those already present is an act of politeness which though dispensable is always appreciated by the Japanese. In the present case the cabin measured twelve feet by seven, and five feet in height, and already five men were squatting on the floor with their personal baggage, preparing to make a night of it. Presently four more came in and that made us twelve, a good-size company for such a cubby hole. Each spread his blanket down in the little crevice that was left for him, and as he tired of the talk and of the smoking—one can imagine how much the volume of smoke poured forth by each of the Japanese, with the exception of our friend, added to the general comfort—each cuddled down, sardined himself in, and was lulled to sleep by the chunk, chunk of the machinery, the occasional tapping of some lingering smoker's pipe on the bronze brazier, and the cradling of the boat as it stood out into the rough, splashing waters of the strait.

Early morning brought us in view of the low, forested sky line of Tane gashima, and we were soon rowed ashore across the little bay of Akaogi, or Nishi-no-omote, where the port and largest village is marked by a group of huts along the coral-strewn beach. We left our belongings on the beach, and threading our way through the gathering crowd of men and boys, and women and girls with babies on their backs, who were flocking to see us, we went to a little inn to make arrangements for a stay.

The *yadoya,* or inn, is one of the most typical and interesting insti-

tutions of Japan. The traveler will find it wherever he may go, now pretentious and from the Japanese standpoint luxurious, now very humble or even dirty. As camping out is next to impossible in that country, we made great use of the *yadoya* throughout our journeying.

As one steps before the wide open doors of the reception room, or into the court, or the kitchen as the case may be, the host approaches and greets with a low bow, followed by the hostess and usually one or more of the maids, who, kneeling, bend to the floor. The salutations are returned, a word is exchanged perhaps about the rooms or the meal that is to be prepared, and the guest seats himself on the low porch or platform that surrounds the entrances, and removes his shoes or sandals, leaving them on the ground. If one wears the Japanese cloth shoe and straw sandal, as I did some of the time, the feet are always washed in a wooden basin of water brought by a maid, who comes clattering around the outside of the house on wooden clogs, to bring it, and sets it down before one on the ground. A little towel is brought too, unless one, as usual, has this most useful of articles about his person. Then the guest steps in, in stocking feet or barefoot, and, preceded by a servant passes through the open rooms, often between a double line of all the people of the household who are bowing to the floor. He enters the room allotted to him and there seats himself cross-legged on a cushion on the matted floor before a tiny charcoal fire in a brazier, and rests—at least pretends to rest if he is a foreigner—until disregard for ceremony gets the better of him and he adopts an easier position. Presently comes a demure or smiling little maid, with rosy cheeks and fancifully colored silk kimono, who kneels outside and slides open the paper door, enters, kneels and closes it, brings tea things to the center of the room, and kneeling pours out a wee cup of tea to the guest or each of the guests. This done she bends her forehead to the floor and patters out, opening and closing the door as before. If the guest is an honored one some dainty, such as bean jelly or cakes, or raw dough rolled in pink and green powder is brought with the tea. Then the guest steps out to the porch to wash, and as he dries his face he looks at the little cultured garden, or off to distant valley, or forest or mountain, or sea. Returning to his room, he is most of the time alone until the coming of the meal; or if it chances to be afternoon or evening, until the announcement comes that "the bath is ready." One is never entirely alone; access to the room is always free on several sides and host, or visitor, or servant, may come in at any time. One becomes used to this and learns to like it in most ways. There is nothing hidden. It makes life simple and informal and more natural. We found it a disadvantage sometimes when we had too many visitors whose curiosity got the better of them, but we always took it in good part, finding it amusing rather than annoying.

After the tea-drinking that morning at Tanegashima, I opened a panel at one side of our room and stepped out on the porch under the low roof. Just before me was the white beach and the water's edge, where two junks that looked for all the world like ancient Spanish galleons were moored; and I looked off beyond to the little rock-hemmed bay banded with green and purple water under the changing cloud shadows, and still farther to the distant pine-crowned sand dunes and headlands fringing the blue of the open sea. To a stranger, such a scene is overpowering with a sense of isolation in which there are mingled elements of loneliness and charm.

Upon the announcement that "go-hang," the meal, or literally, the "rice," was ready, we squatted on the floor and the maid laid before each of us a square tray of viands, and herself kneeled to serve the rice from the wooden firkin. Each tray bore four main dishes, one in each corner, and a cup in the center. There were three bowls, an empty one of porcelain for the main food—rice, another of lacquered wood containing a very thin soup, and the third a mingling of dried fish and seaweed, while the fourth corner was occupied by a plate holding a small baked fish entire. The central cup contained two square pieces of pickled turnip. The maid remained throughout the meal and filled the bowls with rice when they were passed. And, of course, we ate with chop-sticks, drinking the soup. This was a typical hotel meal, purely Japanese, even more elaborate than what one would expect at a private home of people of the middle class, and far better than anything one is served with when traveling in country places away from the seashore.

The island of Tane is not very thickly inhabited and the people are fairly well-to-do. They are half fisher-folk, and the rest farmers or peasants. The low hills that rise from the coast leaving no bordering flat-land are wide and level on the summit, and, in contrast to most of the hills in other parts of Japan, are wooded on their flanks and cultivated on the top. Rice, wheat, yellow mustard for oil, and sweet potatoes are the principal crops. The little fields and patches are usually hemmed in by shrubbery and trees, or often by rows of banana palms. The people live in homesteads that come nearer to being homes as we know them than most of the habitations in other parts of Japan. The low houses with steep thatched roofs are bosomed in gardens of luxuriantly growing vegetables, vines, shrubbery, palms and flowers, with a deep, rich background of old cryptomeria, pine, oak, camphor and banyan trees. It was a pleasure to walk through the rank forest away from the coast on a hot summery day, and there to come upon old settlements framed in the abundant greenery and other coloring of the woods.

One of these old homes situated on the hills above Nishi-no-omote,

was a wide rambling bungalow of wood and paper, roofed with tile and surrounded by a garden of trees trimmed with fantastic artificiality, of flowers and wild growth. Here lived the present member of the ancient noble Tanegashima family that previously ruled the island. My brother called on him one day, and was cordially received, and from him we obtained accounts of the first coming of Europeans to Japan and of the introduction of firearms. It was the custom to keep a family record, and the contemporary account of this episode of the history of the island is most interesting. In addition to the account set down at the time in the family records a complete narrative of the events was written by a priest of the island named Monshi about 1606, or sixty-three years after they occurred, when, as he says, there were still living some old men, with hair as white as the Japanese crane, who remembered the arrival of the foreigners. This narrative he called "Teppoki," or "gun-record." In recent years a history of the Tanegashima family has been written in Japanese by Tokihito Nishimura, and these original accounts are included in it. During some long rainy days on the island our friend Kiyoshi Kanai translated the family records and the "Teppoki," and we studied out their meaning and interpreted them in English as well and as closely as we could. They were written in old-fashioned Japanese and many passages are obscure in meaning and difficult to render.

As the "Teppoki" tells the whole story well and as it incorporates the account given in the family records, I shall give our translation of it, leaving out the other, which would be largely duplication.

There is an island called Tane, 44 miles from Gushu.[1] Our ancestors always lived there. People say that the reason why they call it Tane is that, though it is small, it is full of people and they are all well-to-do. As a seed planted grows and brings forth fruit without end, so multiplied and prospered the dwellers on this island.[2]

On the 25th day of August, 1544, a large ship was found on the beach of Nishi-no-mura, and they did not know from what country it came. The whole crew numbered more than a hundred, the shape of their bodies was not like ours and they could not talk with us. The people that saw them thought them very curious. Among them there was a Chinese student named Goho; we had no way now of knowing his last name. The head officer of Nishi-no-mura was Oribenosho Tokitsura, and he knew a good deal. He met Goho and with his cane he wrote on the sand as follows:[2a] "We do not know whence the crew of the ship comes. How different their figure is!" Then Goho wrote: "They are merchants of the southwest barbarians. Though they know about the principle of emperor and subjects they are ignorant about ceremony. So that when they

[1] The southern province of Kiushiu, now called Osumi.

[2] Tanegashima means literally "Island of seed," from *Tane*—seed, *ga*—of, *shima*—island.

[2a] The meaning of the written characters in Chinese and Japanese is much the same whereas the spoken languages are mutually incomprehensible.

drink they use a large dish, not the cup.[3] When they eat they use their hands and not the *hasu*.[4] They know only to do what their desire tells them, and have no knowledge of literature.[5] They are so-called merchants who travel to places and stay there. They only exchange what they have for what they want and are not men to be suspected."

Then Oribenosho wrote again: "Thirty miles from here there is a port called Akaogi[6] where the owner of the island always stays, where there are several thousand houses and every house is rich and the streets are crowded. If we lay anchor there, there will be no danger, for the harbor is deep and the water smooth." And he sent word to Etoki and Tokiaki.[7]

Now the ship was conveyed by several tens of small fishing boats, and it entered Akaogi on the 27th.

At that time there was a priest named Chushuza, who had come from the Riugen temple of Hiuga and was staying at the port to learn about the Hokke sect, and who finally changed over to be a priest of the Hokke sect from that of Zen, and was called Diuzoin. He knew the sacred books and could write skilfully, and he could speak with Goho. Thus Goho found a friend in this foreign country and felt, as it is said, that there was "one voice, one heart" between them.

There were three head merchants; one was Murashusha and another was Kirishita Demoto.

They had an article in their hands that was about two or three feet long. There was a hole inside of it, and outside it was straight. It was made of very heavy materials. Though there was an empty passage on the inside, this was tightly closed at the end. There was a hole in one side to pass fire through. We could find nothing to compare with its shape. When a man used it, he would put a wonderful medicine[8] into it, add a leaden ball and set up a white mark on the coast; and then he would hold it up, keeping one eye closed and the body straight, put fire through the hole and always hit. When it fires it looks like lightning and the sound is like the rolling of thunder. Every one who heard covered both ears. After marking a white spot on a rock a man could shoot at it very accurately. With the firing off of this thing silver mountains could be destroyed and iron walls dug through. Enemies who do harm to a man's country would be very much frightened on meeting this, and still better would it be for hunting the deer or boar that do injury to young plants. There were many ways of using this article. When Tokiaki saw

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[3] To the oriental, drinking tea or liquor is a significant ceremony and the little porcelain cup is a part of the form. The departure from this way and the use of a large coarse bowl or mug, such as from their standpoint should be used only to eat from, doubtless seemed an indication of barbaric crudity.

[4] What we call, with insufficient reverence, chop-sticks.

[5] "Literature" here connotes learning, culture, ceremonial. These commentaries are interesting; they illustrate another point of view. The bases of judgment are exactly similar to those applied to-day by many Europeans and Americans in passing judgment on the orientals.

[6] This is the chief port and town of the island, now most frequently called Nishi-no-omote. It is the port to which we came, as before stated.

[7] Etoki and Tokiaki were father and son in the ruling house of Tanegashima. The latter was at about this time succeeding his father in the position of responsibility.

[8] The present word for powder in Japanese means "fire medicine."

it he thought it was the most wonderful thing in the world. At first he did not know any name for it or how it was used, but it finally acquired the name "teppo." I do not know whether it was so named by the Chinese or by our island-people.

One day Tokiaki said to the barbarians through the interpreter: "I can not shoot this very well, I wish to learn." The barbarians answered, also by means of the interpreter: "If you wish to learn this we will go to the very bottom of it with you." Tokiaki said: "I would like to go to the deepest principle." The barbarian said: "All that is necessary is to quiet the mind and keep one eye closed." Tokiaki answered: "To adjust one's mind was taught by the old sacred teachers, and that is what I have learned. In general throughout the world if the mind is not under control all conduct will be false. What you say in regard to controlling the mind must mean just this. But about closing one eye—if it is not bright enough without both to put a candle at a distance,[9] is it necessary to close one eye?" The barbarian replied: "Well, everything must be done in a simple way."[10] Tokiaki said gladly: "That may be as Roshi said, 'To say clear, looking small thing.'"[11]

On a certain ceremonial day Tokiaki put a white spot at one hundred steps away, and with the wonderful medicine and a small lead ball he shot pretty closely. People were surprised, and when it hit they were frightened. He said solemnly: "I wish to learn." Tokiaki did not complain about the fearfully high price, but bought two teppo from the barbarians and added them to the house curios. He had the small vassal Sasagawa Koshiro learn the method of making the medicine. Tokiaki studied very earnestly; the first time he shot pretty closely; but later if he shot a hundred times he hit a hundred times, and never failed even once.

At that time a priest named Sugibo of Negoro temple in Kii[12] came to get a teppo, not caring for the distance. Tokiaki was affected by that strong desire for searching, and thought to himself: "In the olden time Jiokun coveted Kisatsu's sword, though he never let it be known by words. Kisatsu found it out and gave him his honorable sword. Our island is small and we can spare one teppo. I came by them unexpectedly and I was so overjoyed that I did not sleep, and had a strong desire to hand them down to my descendants. How much more delighted would a person be to get one after having searched for it. What I like, others will like. Why should I conceal them in boxes?" So he sent Tsuda Kanmotsunojo to Sugibo with one of them and let him know how to make the medicine and how to set it off.

As Tokiaki prized the firearms very highly he had several blacksmiths examine them, and desired them to make new ones. Though they got the shape almost the same they could not discover the way to close the end.[13]

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[9] This probably means, "If with only one eye I can not see any better than by candle light."

[10] Probably means, "It requires concentration."

[11] This probably means that clearness of statement is aided by considering one point at a time. There is a suggestion of similarity here to the passage in Matthew VI., 22, "if therefore thine eye be single, thy whole body shall be full of light."

[12] The Kii peninsula in central Japan, several hundred miles away.

[13] The difficulty that they encountered was probably in finding a way to close the stock end of the barrel, when once they had molded a barrel tube, open at both ends, around a smooth rod. They learned to do this later, probably by screwing in a breech plug and welding the end.

The next year the foreign merchants came back to Kumano. . . . Fortunately there was a blacksmith among them. Tokiaki thought that to be a gift from heaven and ordered Kimbioe Kiyosada to learn the way to close the end. After awhile he learned how to do it by means of a screw. Thus in the course of a year they were able to make several tens, and after that they made the wooden parts and the other decorations.

This completes the main portion of the "Teppoki," but the family record of the smith Kimbioe Kiyosada which is also preserved forms an interesting addition. Here is a translation of part of this contemporaneous account:

Kiyosada brought about the relation of teacher and pupil between one of the strangers and himself with the purpose of learning the way to make the teppo. He thought that the barbarian would never tell the truth and that it would be better to give his daughter to him and let him marry her. Though he learned how to shape the teppo he did not understand how to close the end. After several months the ship went away, with the daughter, and many presents were left.

The record goes on in more detail and tells us the outcome. The daughter was seventeen years old and her name was Wakasa. After a year's time the ship returned, as the other records tell also, and Kiyosada found out how to complete the making of the firearms. Wakasa returned to her parents, and the family in order to keep her pretended to the strangers that she was dead and that the burial ceremony had taken place. The family of Kiyosada still lives on Tanegashima and is in possession of some porcelain ware presented at the time by the merchants.

The foregoing narrative is a history of the discovery of Japan by Europeans from the standpoint of the Japanese themselves. It is interesting to compare with this the story as written by one of the discoverers. The Portuguese navigator, Ferdinand Mendez Pinto, after returning home, described his many experiences in his book "Peregrinaçaõ," and among them, his arrival at the island Tanegashima, or, as he called it, *Tanixumaa*.

He set out from Cochin China for a journey in the China seas, and after various wanderings through the Liu Kiu islands and elsewhere came by chance upon Tanegashima. This was the first time that any portion of Japan had been seen by Europeans. He was accompanied at this time by two other Portuguese, *Diego Zeimoto* and *Christovano Borralho*.[14] Later he went to other parts of Japan farther north. The

[14] The names in the Japanese account were *Murashusha* and *Kirishita Demoto*. As one Japanese writer says, foreign names are to their people "like cold water to the sleeping ear." The names must have been ill understood and imperfectly represented in the Japanese syllables and there may have been a still further departure from the original in the present retranslation. The former may stand for *Mendez Pinto*. The first name of the second doubtless stands for *Christovano* (*Bolero*), (the Japanese now say *Kirish* for *Christ*),

whole story is most interesting, but there is place for only a few extracts here. Their junk hove to first at the southern end of the island and was then conducted by native boats to "a great town, named Miaygimaa"[15] where the chief nobleman of the island soon came on board. The account reads:[16]

He no sooner perceived us three *Portugals*, but he demanded what people we were, saying, that by our beards and faces we could not be *Chineses*. . . . Thereupon having called a woman of *Lequia*,[17] whom he had brought to serve as an interpreter between him and the *Chinese*, captain[18] of the junck; "*Ask the Necoda*, said he unto her, *where he met with these men, and upon what occasion he had brought them hither with him into our country of Jappan?*" The captain thereunto replied, that we were honest men and merchants. . . . After he had seen all the commodities in the junck, he sate him down in a chair upon the deck, and began to question us about certain things which he desired to know, to the which we answered him in such sort, as we thought would be most agreeable to his humour, so that he seemed exceedingly satisfied therewith; in this manner he entertained us a good while together, making it apparent by his demands that he was a man very curious, and much inclined to hear novelties and rare things.

On leaving the vessel the lord of the island asked the strangers to come ashore and visit him, and they did so, being royally entertained and answering many questions regarding the world from which they had come, which was entirely unknown to the Japanese. Within three days all the goods on the ship were disposed of at great profit, but Pinto and his companions remained on the island after that more than five months. Again the narrative reads:

Now as for us three *Portugals*, having nothing to sell, we imployed our time either in fishing, hunting or seeing the temples of these *Gentiles*, which were very sumptuous and rich, whereinto the *Bonzes*, who are their priests, received us very courteously, for indeed it is the custom of those of *Jappan* to be exceedingly kind and courteous. . . . *Diego Zeimoto* went many times a shooting for his pleasure in an harquebuse that he had, wherein he was very expert, so that going one day by chance to a certain marsh, where there was a great store of fowl, he killed at that time about six and twenty wild ducks. In the mean time these people beholding this manner of shooting, which they had never seen before, were much amazed at it. . . . The lord of the island sent presently for *Zeimoto*, just as he was shooting in the marsh, but when he saw him come with his harquebuse on his shoulder, and two *Chineses* with him carrying the fowl, he was so mightily taken with the matter, as he could

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and the last name for *Zeimoto*, especially as the Japanese account says distinctly that there were three men.

[15] The name of the chief town which was then as now the chief one of the island, and to which Pinto came according to the Japanese account, is Akaogi or Nishi-no-omote. He evidently confused with it the name of the small island Mage-shima that lies a few miles out to sea in front of the town.

[16] From the translation by H. C. Gent published in London in 1663.

[17] Pinto's version of Liu Kiu, the name of the island chain to the south.

[18] The three Portuguese were then traveling in the vessel of a Chinese pirate.

not sufficiently admire it; for whereas they had never seen any gun before in that country, they could not comprehend what it might be, so that for want of understanding the secret of the powder, they all concluded that of necessity it must be some sorcery.

The story goes on to tell how the nobleman took Zeimoto up behind him on his horse and had criers declare through the town that thereafter he considered him as his kinsman, and that he should be treated accordingly on pain of death. The lord treated Zeimoto very kindly, and the latter, according to Pinto, presented his harquebuse to the lord, who gave him in return 1,000 *tæls* silver.[19] The lord took more pleasure in shooting the gun than in anything else, and many of his subjects set to work to learn to make firearms. Pinto says that when he returned to Japan another time, which was in 1556, he was amazed to find how the art of making guns had spread, and he says that on expressing his amazement:

"Certain merchants of good credit assured me that in the whole island of *Jappan* there were above 300,000 harquebuses. . . . So that by means of that one, which *Zeimoto* presented to the *Nautaquim* in acknowledgment of the honour and good offices that he had done him . . . the country was filled with such abundance of them, . . . whereby one may perceive what the inclination of this people is, and how much they are naturally addicted to the wars, wherein they take more delight than any other nation that we know.

The first finding of Japan by Europeans opened the way to the coming of more merchants, and missionaries. It was not long after that St. Francis Xavier came and converted large numbers of the Japanese to Christianity and started this new religion, which in later years gained such a firm rooting and developed among the Japanese some of the bravest Christian martyrs known to history. During following centuries a very important trade continued between Japan and the Portuguese, Spanish and Dutch until the country was opened to the world by America in 1854.

We found the people in many of the out-of-the-way parts of Japan not much altered, it would seem, from what they were centuries ago, and just as much filled with curiosity as they were then at the coming of "red-haired barbarians with green eyes." To cite just one instance —one day an old man who had never seen a foreigner before sat for half an hour outside our door, which happened to be a little open, and watched us while we were eating. I heard later that his comment was—"they have beautiful complexions but I do not like their hair." A light complexion is always considered an element of beauty, and for this reason a large proportion of the girls use powder, although their faces are in general whiter and rosier naturally than the men's. Black hair is, of course, an element of beauty, and sandy hair such as ours is not, since black is practically the only color known among themselves;

[19] Compare this with the Japanese account of the transaction.

and as for blue eyes—if a Japanese, having never seen them, could imagine them at all it would only be with horror.

The people of Tanegashima are rather easy-going, and along the coast are often poor and dirty, rather from indolence than lack of opportunity. When not lounging idly they are at their fishing or sea-weed gathering, or the women in their sweet-potato patches. All down the rocky coast one sees ragged children playing, and naked men with well-formed bodies of the color of bronze, working at their boats and nets or swimming in the sea with baskets gathering edible sea-weed. In the fields, too, the peasants work almost naked during the warm days. The coast is one of rocks and pools and waves, of fish-nets spread out to dry, of dirty fishing shanties, of coral walls surrounding the yards, of salt-making paddies, and long reaches where nothing grows but grass and shrubs and pines.

Our wanderings took us along the coasts, across the island and down its center, and afforded us many experiences and views that are memorable. Toward the southern end we stayed one night at Kumano Bay on the eastern coast, the place to which the foreign ship of Mendez Pinto came first, and where lived the blacksmith Kiyosada who first learned to manufacture firearms. Here there is a large inlet among the hills that is filled with water only when the tide is in, where one sees "now horseback riders and now the white sails of boats" as one Japanese writer quaintly puts it. We walked across the dry, flat floor of the bay one evening on our way out to the seacoast to examine some caves. Returning after dark we started across it and found it full of water up to our waists. At every step we took, the disturbed bay gleamed with phosphorescence in a circle all about us and made a fine picture here in the valley of water between pine-crowned hills that stood out even blacker than the night. Here where the landscape changes with the tide is the holiest place in the island, and we had the pleasure of spending the night with the priest of the Shinto shrine in an exquisitely beautiful Japanese house that had just been built for him. He lived alone, but called in a charming lady and her perfect little daughter from the neighboring hamlet to prepare our food. The meals were very simple, but neatly and daintily served, after the general plan of the meal before described. The priest did not eat with us, but we sat with him and talked for some time by the open fire that was burning in a basin in the floor. The custom of having fires differs among the Japanese. Usually in the hotels and private houses there is a wood fire on the dirt floor or in a rough stove in the kitchen, and nothing but braziers in the living rooms. But often also, in the country homes especially, open fires burn in a round hearth in the center of the house. There is never a chimney, and in the present case the rich new wood-work of panel and ceiling was fast becoming blackened with smoke from the tarry pine wood.

We went to sleep on short mattresses on the floor, under covers of silk, and so passed one of the last of our nights in Tanegashima. Before leaving this southern end of the island the next day I climbed a high hill and saw the great blue mass of the island Yakushima that rises under a dense cover of old forests over six thousand feet out of the sea not far away. To this island I sailed a few days later, while my brother left me to go back to the north.

It was just at the time when the long expected Russian fleet was gradually crawling toward Japan, and the whole country, ignorant of the fleet's whereabouts and of the route that it might take, and not knowing at what moment it might strike, was calmly and confidently awaiting its arrival. On several different days we had heard occasional distant rumblings that did not sound at all like thunder and did not approach nearer. We thought to ourselves, could that be distant cannonading? But although the noise was probably due to distant thunder storms it added something of awe and doubt to the suspense. Finally the news came, and the intoxicating, unbelievable story of wholesale success was quietly received and at once believed by the people as if it were only what had been expected. A couple of days after the great victory, as I was sailing across the straits to Yaku Island, I saw a Japanese war vessel swooping down the coast of southern Kiushiu, probably in search of any Russian ship that might possibly have escaped. The war, now almost ended, which had been carried on with such assured skill by the Japanese, gave an added significance to the first introduction of firearms and a prophetic truth to the words of Mendez Pinto at the end of the passage quoted above, and to the following words with which the priest Monshi summed up his "Teppoki":

After this, throughout the eight provinces, and even in the country districts, every one obtained guns and practised. . . . In the first place Tokiaki got two guns from the foreigners and learned their use. One shot shook all Japan.

AN AMERICAN CONTRIBUTION TO THE HISTORY OF THE PHYSIOLOGY OF DIGESTION

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MY interest has lately been aroused in reading a little American monograph published over a hundred years ago as a dissertation submitted for the degree of doctor of medicine to the faculty of the University of Pennsylvania. It is entitled: "An Experimental Inquiry into the Principles of Nutrition and the Digestive Processes," by John R. Young, of Maryland (submitted June 8, 1803).[1] The essay does not appear to have received notice from the writers of that period; nor was there, probably, more occasion for calling attention to this monograph than to the usual doctor's thesis of the present day. Dr. Young's contribution, nevertheless, seems noteworthy because, in examining the knowledge of digestion then current, he applies the test of experimental evidence obtained at first hand—a sort of critique less in vogue in his day than in ours. On the title page he quotes from Lavoisier: "We ought in every instance to submit our reasoning to the test of Experiment, and never to search for truth, but by the natural road of Experiment and Observation." The dissertation further possesses a value, aside from its intrinsic merit as a scientific inquiry, in giving some indication of the status of physiological studies in America at the opening of the nineteenth century and in the first medical college of this country. To appreciate Dr. Young's monograph in the light of those times one must indulge in a moment's retrospect.

The history of the physiology of digestion may conveniently be divided into three periods. The first of these embraces the earlier days of science until the publication of Haller's "Elementa Physiologiæ" (1757), when theory and debate still maintained the triumph of the "animal spirits" and the various conceptions of "vital principles." In the succeeding epoch Réaumur (1752), Stevens (1777) and Spallanzani (1783) put into practise the teaching of Bacon:

> Non fingendum aut excogitandum, sed
> quid natura faciat observandum.

[1] I am indebted to Dr. C. F. Langworthy, of Washington, for directing my attention to this paper. It is reprinted in the Medical Theses, edited by Charles Caldwell, M.D., Philadelphia, Thomas and William Bradford, 1805, which was obtained for the Yale University Library through the courtesy of the Library of the Surgeon General's Office in Washington.

Previous to this time various theories of digestion were based upon obscure ideas of trituration, concoction, fermentation and putrefaction or whatever these words might imply. Difficult as it is for us to-day to reproduce the point of view of men who were "struggling with the spiritualistic fermentations of van Helmont, on the one hand, and with the material effervescences of Sylvius, on the other," we can nevertheless appreciate the remark of William Hunter:

> Some physiologists will have it, that the stomach is a mill, others, that it is a fermenting vat, others, again, that it is a stew-pan; but, in my view of the matter, it is neither a mill, a fermenting vat, nor a stew-pan; but a stomach, gentlemen, a stomach.

The third epoch in the study of the physiology of digestion coincides with the rise of modern chemistry and may, perhaps, be said to start with the discovery of free hydrochloric acid in the gastric juice by Prout and by Tiedemann and Gmelin in 1824, soon followed by the pioneer work of Dr. William Beaumont upon Alexis St. Martin. Foster writes:

> It was left for the nineteenth century to throw a new light on the nature of the gastric changes and at the same time shew that what took place in the stomach was not the whole of digestion, but only the first of a series of profound changes taking place along nearly the whole length of the alimentary canal.

Let us bear in mind, then, that although the presence of a solvent fluid in the stomach had begun to be admitted in 1803, its nature and the mode of its operation were not understood until Beaumont's classic experiments (1833) on "the man with a lid on his stomach," as St. Martin was derisively called. Réaumur (1752) experimented on a buzzard, administering to it hollow metallic capsules perforated like a sieve and containing foods within. The possibility of mechanical crushing or trituration was thereby excluded; but when the tubes were regurgitated it was found that digestion (solution) of the food materials had nevertheless taken place. Some chemical action must have been exerted; and by placing sponges in the metallic tubes, Réaumur was able to express therefrom specimens of gastric fluid. He appreciated that it possessed properties antagonistic to putrefaction; and fragmentary as his observations may appear, he introduced a new method into physiological research. To Spallanzani was left the extension of these investigations in most fruitful fields. He well recognized the antiseptic power of the gastric secretion. With regard to the nature of digestion Spallanzani concluded (1783) in these words:

> None of the three forms of fermentation distinguished by chemists under the name of spirituous (alcoholic), acid, or putrid, have any place in digestion.

His well-conceived experiments in which animals swallowed meat attached to strings by which it could be withdrawn from time to time,

and the ways in which gastric fluid was removed by squeezing out sponges swallowed and withdrawn, are familiar. The impression which these researches left is well emphasized by Beumont. He wrote (1833):

> Suffice it to say that the theories of *Concoction*, *Putrefaction*, *Trituration*, *Fermentation* and *Maceration*, have been prostrated in the dust before the lights of science, and the deductions of experiment. It was reserved for Spallanzani to overthrow all these unfounded hypotheses, and to erect upon their ruins, a theory which will stand the test of scientific examination and experiment. He established a theory of CHEMICAL SOLUTION, and taught that chymification was owing to the solvent action of a fluid, secreted by the stomach, and operating as a true menstruum of alimentary substances. To this fluid he gave the name of GASTRIC JUICE. . . .
>
> By far the most respectable and intelligent physiologists have now settled down in the belief that chymification is effected in the stomach, by a specific solvent, secreted by that organ, called, after SPALLANZANI, the Gastric Juice. From the difficulty, however, of obtaining and submitting this fluid to the test of experiment, and the diversity of results in the examination of such as has been obtained, no very satisfactory conclusions have been arrived at. The presence of an active solvent is rather an admission—a conclusion from the effect to the cause.

Spallanzani failed to understand the acid character of solvent gastric juice. Even as late as 1825 Leuret and Lassaigne, in a memoir honored by the Académie des Sciences, declined to accept Prout's evidence of the existence of hydrochloric acid in the gastric secretion. This deserves notice with reference to the experiments of Dr. Young which will be described later.

Young's essay opens with a review of the Nutrientia, the views of Dr. Cullen being subjected to criticism. This famous Edinburgh teacher[2] referred "the principal of nutrientia to vegetables; and that they derive this property from their acid, sugar and oil." Taking these up in order, Young rejects acid as a true nutrient, with these words:

> The doctor (Cullen) appears to have founded his opinion on the idea, that all vegetable substances, when taken into the stomach, undergo a fermentation, whereby an acid is evolved; and "as this entirely disappears with the progress of the aliment, without being again evident in the mass of blood," so he supposed it undoubtedly entered into the composition of the animal fluid. That an acetous fermentation takes place in the human stomach in a healthy state, we entirely reject, as will appear in what follows; and if this opinion be well founded, we obviate the principal argument favouring the idea, of an acid being nutritious. Acescent vegetables we can not doubt as affording nourishment, but this is not to be referred to their acid, but to their sugar and oil.

Young overthrows Cullen's assumption that "sugar is not alimentary in its pure saline state, but only when combined with an oleaginous

[2] I have assumed that the writer must refer to William Cullen (1712–90), of Edinburgh, under whose influence the abler young men from the English colonies in America came.

matter," by citing the case of the West Indies negroes who grow fat on sugar at certain seasons when they are at work on the cane. The absorption and need of water and "calcareous earth" is also discussed. The author reaches the conclusion that water not alone supplies the waste of fluids, but also goes to form the solids of the body. He says:

> Dr. Fordyce informs us he put a gold-fish in a glass vessel, and supplied it with spring water; the fish lived in this manner for fifteen months, grew to more than double the size it was when first confined, and threw out much feculent matter. Lest it should be supposed the fish lived on substances held in the water by solution, he used distilled water and impregnated it with the air of the atmosphere, and put other gold-fish in the water thus treated, and kept them six months,[8] during which time they threw out feculent matter, and thrived as before mentioned.

In referring to the "action of the mind" on the secretion of saliva Young makes the following comment in a foot-note:

> Is not the secretion of the saliva and gastric juice synchronous? It is highly probable from long habit, the actions of these two sets of vessels become associated; hence, when the stomach and its vessels are irritated, as in nausea, there is always a flow of saliva, though nothing stimulating has been applied to the mouth. The excitement of the vessels of the one seems to keep pace with that of the other; when the nausea is so great that vomiting is just at hand, the flow of the saliva is proportionally increased; and when we make an unsuccessful effort to vomit, we generally throw out a mouthful of saliva.

Is it far-fetched to recall in this connection the comparable psychic secretion which has been described in recent years for both saliva and gastric juice and the probability of a common stimulus for the production of each?

Let us now consider more particularly Dr. Young's observations on the processes in the stomach. He assumes that sufficient evidence was already at hand from experiments on animals to permit plausible, if not conclusive, inferences concerning our own digestion. He writes:

> It would be unnecessary to recite particular experiments, to prove the solvent property of the gastric fluid, this being admitted on all hands. . . . The effects of solution are most remarkable in such animals as swallow their food without mastication; we will, therefore, relate a few experiments made on some of these.
>
> Our common large bull-frog (*Rana ocellata*) was chosen in order to observe the effects of the gastric fluid, as they swallow all their prey whole. They have a large membranous stomach, which when distended, occupies the whole anterior part of the abdomen: the œsophagus is very wide, so that their food can be examined at pleasure. Two of a very large size were procured, and their stomachs were found to be greatly distended with food: being desirous of seeing what was their natural aliment, and the effects of their digestive power upon it, by means of a pair of forceps, one of their stomachs was easily emptied of its contents; and to my surprise, and that of others who witnessed the fact, it was found to contain a common sized spring frog, and afforded a fine oppor-

[8] One is reminded of J. Loeb's demonstration nearly a hundred years later that certain fishes can be put into distilled water without the least injury.

tunity to see the effects of their gastric liquor. The whole external surface of the frog was acted upon, the muscles having, superficially, quite lost their texture; some parts of the backbone were bare, the spinous processes of which were quite soft. Upon introducing a forceps, a second time, the hinder parts of a second frog were found, which shewed the effects of their fluids in a still greater degree: the muscles of the thigh were reduced to a complete jelly, though still retaining their form; some parts of the bones that were covered with flesh were quite soft and flexible. Upon extracting the contents of the stomach of the second frog, it was found to contain a field mouse, about a third larger than our common mouse: its whole surface was quite soft, having entirely lost its texture; the fore legs were nearly disconnected from its body, the bones of which were soft; the bones of other parts of the body were also examined; they were all soft. But what was most surprising, the teeth of this animal did not escape; the incisors were, as Dr. Jacobs witnessed, soft and flexible, having the appearance of a piece of half dried tendon. Neither the frog nor the mouse had any acid or putrid smell.

It appeared very evident from the preceding experiment that the fluids of these animals acted upon bones; but in order to ascertain whether they could dissolve them completely down, the following experiment was performed. The head and all the bones of the mouse were cleared of their flesh, and forced into the empty stomach of one of the frogs; he was then put into a jar of water. In two days, the bones were all discharged in the form of a mortar; by rubbing it between the fingers, small pieces of bone were distinguishable. This will serve to shew us the powerful action of an apparently inert fluid on an animal matter, sparing not bones, nor even the teeth of animals.

Being desirous of knowing the length of time they would require to dissolve down a small frog, the following experiment was performed. A packthread was tied to the hind legs of a living spring frog; its head was then put into the mouth of one of the large frogs; as soon as he felt it move it was swallowed greedily. In five hours it was drawn up by means of the thread; the skin and external surface of the muscles were tender. It was again introduced; in the space of seven hours, it was drawn up a second time; the abdominal muscles were now dissolved, and the intestines had protruded; the bones of the feet were soft, and separable from the leg by the least force; in a word, the whole was a complete dissolved mass. It was swallowed a third time, and attempted to be drawn up in six hours afterwards; but it had so far lost its texture that the two legs, to which the thread was tied, could only be brought up; the bones of these were soft and flexible, as before mentioned. Many experiments of this kind were made to see the effects of their gastric menstruum: in many cases, after giving them small frogs, the trunk and head of these animals were drawn out of their stomachs complete skeletons, but the bones were always soft, and felt like tender cartilage. In all the half-digested substances which were at different times taken from their stomachs, as frogs, veal, beef, etc., an acid was constantly found present: they were seldom examined before two hours after being swallowed; at this short interval when their surfaces were touched with litmus paper, it was turned red.

Snakes, like the large frogs, also swallow their food without mastication: many experiments were therefore also made on them, by forcing frogs, lizards, etc., into their stomachs, to see the effects of solution: they agreed in every respect with what has been said of frogs, like them perfectly dissolving down entire animals. The only difference between them was, that the solution of snakes went on only about half as fast as that of the large frogs.

The gastric fluid of man and that of frogs and snakes agree perfectly in their action on flesh, as the experiments of Spallanzani prove that the first of these powerfully dissolves meat out of the body. As the menstruum of the two latter animals acted so uniformly on bones, it appeared highly probable the fluid of our own stomach would also. To ascertain this, the condyles of the thigh bone of a chicken, weighing eleven grains, were swallowed; the bone remained a considerable time in the stomach, as was supposed from some uneasy sensations that were occasionally experienced for between two and three days; the fourth day it was discharged, reduced to a shell, weighing only three grains. Thus far the digestion of man and these animals perfectly agree, in solution being the first step towards the conversion of food into chyle; but they differ in some particulars, and probably by attending to these, they may be of use to us.

First. They are cold-blooded animals: heat is a powerful agent in all solutions, and the experiments of Spallanzani prove it greatly assists the action of the gastric liquor out of the stomach.

Secondly. They do not masticate their food.

These two inconveniences are obviated, by these animals never drinking when their digestion is going on, so that their fluid acts in its undiluted state; whereas in man, it is always diluted, as he seldom eats without drinking. That this was the case with these animals I had clear proof; for although I examined the contents of their stomachs so often, in no one case could I find any fluid more than a jelly-like substance, appearing to be made up of gastric juice and dissolved flesh. Supposing, however, that the pressure used in bringing up the food of the frogs might have forced the more fluid parts into the duodenum, I resolved to ascertain the fact in another way; this was easily done. A teaspoon could readily be passed into their stomachs, and with this the dissolved food could all be brought up; it was always, however, of the consistence above mentioned. During the time these experiments were made, they were constantly kept in large jars of water. The attention to this circumstance by these animals, which swallow their prey entire, is a necessary part in their digestion, as they require a very powerful menstruum, so as to dissolve not only entire muscles, but also bones. The inference we would draw from it would be, to attend occasionally to what necessity urges them to observe constantly. Thus when our stomachs are weak, or we are troubled with dyspeptic symptoms, like them we ought to avoid much diluting our gastric juice; so that although it were secreted not perfectly healthy, yet having the advantage of acting in its uncombined state, solution and digestion may go on, when it otherwise would not, with the common quantity of drink. Indeed our stomachs in this respect act a kind part to us; for when we make our first dish on broth it seldom relishes much solid aliment after it; hence soups are the first dish at the table of the temperate, and the last at that of the epicure.

Both Spallanzani and Réaumur believed that vegetable food is less easily digested by certain animals than meat. Young reinvestigated this question on frogs. He found that when peas, beans, wheat and bread enclosed in linen bags were introduced into the stomach, all but the bread were still entire at the end of thirty hours; but when the peas and beans were well bruised before introduction they were dissolved. The author concludes that the *living principle* in the seeds resists digestion. In harmony with this view he found that seeds would germinate when retained in the stomach. An entertaining story is cited from the Italian anatomist Morgani.

He informs us that a young lady living entirely on vegetables (it being lent), was seized with a violent affection of her stomach, and great emaciation ensued. Different medicines were used, but without the least alleviation of her symptoms. At length a violent vomiting commenced, and to the astonishment of all present, she threw up a small plant, with perfect leaves and roots! This at first sight might be looked upon as approaching the marvellous; yet why should we doubt it? The authority of our author is as respectable as any other of our profession; and we have just seen that seeds will vegetate when retained a sufficient length of time in the stomach. The probability here was, that the young lady had swallowed the seed of some small plant, without destroying its texture by mastication; which being retained in the stomach, and exposed to heat and moisture, vegetation progressed.

Vegetable and animal foods alike are, then, capable of solution by the gastric fluid, provided that their "organization or vital principle be previously destroyed." One could thus believe the further evidence that "a respectable gentleman" had seen two polar bears "that had subsisted on vegetable food alone, from the time that they were taken from their mother's breasts; and that they were more than half grown, and very fat." On the other hand, he cites the case of the Italian naturalist who "by dint of hunger learnt a pigeon to eat meat of which it became so excessively fond, that it preferred it to every other kind of food, even to wheat, which in their natural state, they eat before anything else."

Will simple solution by the powerful action of the gastric fluid explain the conversion of "aliment into chyle?" asks Dr. Young. Many earlier teachers had assumed that activities which we now know to be associated with microorganisms play a part. The warmth and moisture of the body would facilitate this fermentation and putrefaction. Our author writes:

Chemists divide fermentation into three kinds, the vinous, acetous and putrefactive; the product of the first is vinous spirit, or alcohol; of the second, acetous acid, or vinegar; of the third, ammoniac, or volatile alkali.

In order to ascertain whether a vinous fermentation could take place in the human stomach the following experiment was performed. My friend, Mr. Mitchell, avoided his usual breakfast, in the place of which he took, between the hours of eight and ten, twelve ounces of sugar. Nothing more was taken until one o'clock. Having the power to ruminate, it was at this hour thrown up; the mass was sweet: upon being put to rest no intestine motion or disengagement of air was to be perceived. It was then submitted to distillation: a limpid fluid passed over into the receiver, which was sweetish, but had none of the properties of a vinous spirit. Carbonic acid gas is constantly evolved during the vinous fermentation; Mr. Mitchell, therefore, paid particular attention to this, as long as the sugar was on his stomach; but there was not the least eructation of air during the whole period the experiment was going on. If ever a vinous fermentation took place in the stomach, we expected to have found it in this experiment; as this viscus was plentifully supplied with saccharine matter, which passes so readily to this state; but as nothing of the kind occurred, we conclude the vinous fermentation has nothing to do with the digestive process.

Young's experiments on frogs had already taught him, in confirmation of Spallanzani, that the gastric juice resists decay and it "even restored putrid substances to their original sweetness." Here is an additional experiment upon himself:

On an empty stomach I made a light dinner, on chicken pye, and drank simple water: in half an hour, by irritating my fauces, it was thrown up; at this time it was plentifully supplied with gastric fluid, as well as saliva, as the quantity of food was but small. It was then exposed in a tumbler to a heat equal to the human temperature. For the space of nine hours there was not the least intestine motion nor any disengagement of air. As digestion is performed sooner than this period, it was not attended to any longer.

Young convinced himself of the acid character of the gastric fluid and attempted to identify the acid present.

A piece of fresh veal was introduced into the empty stomach of one of the large frogs: in two hours it was examined; the surface was a little tender; upon being touched with litmus paper it was turned red. Here digestion was progressing quite regular, yet an acid was present. It appeared impossible at the same time to conceive the meat could become sour in so very short a time, and in so very low a temperature; it was therefore conjectured, the acid was to be referred not to the meat, but to the gastric juice, which the following experiments confirmed us in. A frog was kept starving for two days; a piece of litmus paper was then forced into its empty stomach by means of a pair of forceps; upon being drawn out, it was covered with gastric juice, and the litmus turned red. The naked gastric juice was afterwards often examined, by bringing it out of their stomachs with a teaspoon, and constantly found to be slightly acid. Being thus fully persuaded the acid, in the digested food of frogs, did not arise from a fermentation, but was to be referred to their gastric juice, we were led by analogy to suppose the acid of our own stomachs was to be attributed to the same origin: but this analogical reasoning might be called mere probability; the following experiment was therefore performed. Early in the morning, my stomach being empty, I irritated my fauces with a view of throwing up some gastric juice: though many efforts were made, none could be vomited. The following day I took some meat on an empty stomach: in half an hour afterwards, by irritating my fauces, the meat was thrown up, and with it some gastric fluid: upon being tested, an acid was very evidently present. Here no one can suppose the acid was to be referred to the meat. We have little hesitation, therefore, in saying that the acid so constantly found in the stomach of man, and almost, probably, all animals, is to be referred to their gastric fluid.

Young's friend, Mr. Mitchell, "being in good health and having the power to ruminate," collected gastric fluid for him. The analysis of the filtered fluid was performed by precipitating with acetate of lead. The precipitate was treated with muriatic acid "which decomposed it, a very white powder remaining at the bottom, and a fluid above." From analogy with the behavior of urine similarly treated the author concluded:

Though great accuracy and many varied experiments are required to ascertain certainly the presence of an unknown acid, yet we are disposed to believe any person who had witnessed the great similarity in the comparative precipita-

tions just mentioned would have pronounced the same explanation was to be applied to both, or that the acid in the filtered fluid was the phosphoric.

Additional evidence of the presence of phosphoric acid was believed to be derived from the behavior of the fluid towards solutions of mercury or silver in nitric acid and towards lime water.

The supposed finding of a mineral acid led Young to comment upon the efficiency of metallic iron recommended by Italian physicians as a tonic, its solution being thereby explained. For, he asks, "does not the uniform effects of iron in its metallic state prove that an acid is always present in the stomach?"

The solvent property of the gastric juice on bones and teeth suggested the possibility of its use as a solvent for stone in the bladder.

A calculus was obtained from Dr. Jacobs of a very firm texture weighing exactly fifty grains. It was introduced into the stomach of one of the large frogs. In two days it was taken out for examination: at first sight it was evident solution had taken place, for the gastric juice which adhered to it was coloured with some of the dissolved stone: it was found to weigh forty-five grains. It was forced into the stomach a second time, where it remained for two days; it now weighed thirty-eight grains: from this, it appears, it is well worthy of more attention. When introduced into the bladder, with the heat of the human body, we have little doubt the gastric juice of frogs would act upon calculi with much effect. The fluid is easily procured, and without the necessity, as in other animals, of sacrificing a life every time we wish to obtain it: by means of a teaspoon it is readily brought up from their stomachs.

With the theory of fermentation rejected, the author proceeds to attempt an explanation of the digestive function.

Aliment is dissolved by the gastric menstruum; it then passes into the duodenum and meets with bile and pancreatic liquor; after being united with these, a heterogeneous mass is formed called chyme, and from this the lacteals secrete chyle.

We are led to believe this to be the true doctrine, because, as before observed, simple solution will not explain the phenomenon of digestion; nor will the mixture of this dissolved mass, with bile and pancreatic liquor, change it into chyle; for we know chyle is formed when both these fluids are wanting: thus nutrition goes on when the biliary ducts are obstructed, and also when the pancreas is schirrous. That the absorbents have a secreting or digestive power, we learn from the following. Dr. Wistar informs us of a remarkable case, which occurred under his own observation, of a person who was supported for many weeks, by nourishing enemata, alone. Here it can not be said there was bile, gastric and pancreatic liquors to assimilate the injected fluid into chyle; yet chyle was formed and the system nourished. If the lacteals acted the part of simple absorbing, or capillary tubes, their contained fluids ought to partake of the sensible properties of the mass from which they are absorbed. But the reverse of this is the case: chyle has always the same taste, however different the sensible properties of the contents of the intestines may be, whether they are acid, bitter, etc. We draw a strong argument in truth of this opinion, by turning to the vegetable kingdom, throughout the whole of which the digestive process is seated in the absorbents. Water is to them what the fluids of the primæviæ are to the digestion of man: it dissolves their

food, which being exposed to their vessels is taken up; but the fluid thus taken up can not be imitated by any mixture of earth and water, any more than we can imitate chyle by combining aliments with the fluids of the alimentary canal. As we thus have proofs the one is a secretory process, why not admit that of the other to be so also, since the circumstances of each so perfectly agree.

One hundred years later the obscure importance of the absorbing alimentary tract must still be emphasized. In the words of a popular textbook: the energy that controls absorption resides in the wall of the intestine, presumably in the epithelial cells and constitutes a special form of imbibition which is not yet understood. Thus the dignity of the living structures still remains unchallenged.

The uncertainty regarding the acidity of the gastric juice which still prevailed twenty years after Young's paper was published has already been mentioned. Even as late as 1812 Montegre insisted that what was supposed to be gastric juice is nothing but swallowed saliva. An American, Professor Smith, suggested that digestion is performed "by the *veins* of the stomach, and by the *liver*." Vague ideas like these, in contrast with modest experimental inquiries illustrated by the monograph which we have reviewed in some detail, led Dr. Beaumont to remark:

It is unfortunate for the interests of physiological science that it generally falls to the lot of men of vivid imaginations, and great powers of mind, to become restive under the restraints of a tedious and routine mode of thinking, and to strike out into bold and original hypotheses to elucidate the operations of nature, or to account for the phenomena that are constantly submitting to their inspection. The process of developing truth, by patient and persevering investigation, experiment and research, is incompatible with unrestrained genius. The drudgery of science is left to humbler and more unpretending laborers. The flight of genius is, however, frequently erratic.

THE INSTRUMENTS AND METHODS OF RESEARCH[1]

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WERE I to accuse you of forgetfulness, of shortness of memory, or possessed of that quality apt to prove troublesome to others, though characterized by the oldest of our past presidents, in his delightful "Reminiscences of an Astronomer," as a valuable quality—absent-mindedness—I dare say you would not be much offended, though possibly a trifle annoyed. But were I to accuse you of *narrow*-mindedness I might meet with a different reception. To none of us would it matter much to be called short-memoried or absent-minded, but to be termed *narrow-minded* arouses our resentment immediately. But are we not all necessarily so, more or less, according to the circumstances in which we find ourselves?

Mind the Chief Instrument of Research

I believe it was the mathematical physicist Stokes who warned us we must not forget that the chief instrument of investigation—the mind—is itself the object of research. To the mind, then, we should devote our first and chief attention in the discussion of the subject for this evening. How to reduce and check as far as possible this natural tendency of all of us to narrow-mindedness in one or more directions, or how, realizing its necessary existence, to make due allowance for it in the formulation of conclusions which, though drawn with utmost care, are nevertheless subject to "personal equation," is, as we at once readily see, a matter of the very highest importance.

Many of you are doubtless familiar with the Hindoo fable set to rhyme by Saxe:

It was six men of Indoostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind.

The *First* approached the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me! but the Elephant
Is very like a wall!"

[1] Address of the retiring president, delivered before the Philosophical Society of Washington, Saturday evening, December 5, 1908.

The *Second*, feeling of the tusk,
  Cried, "Ho! what have we here
So very round and smooth and sharp?
  To me 'tis mighty clear
This wonder of an Elephant
  Is very like a spear!"

The third, happening to grasp the "squirming trunk within his hands," declared the elephant to be "very like a snake"; the fourth, feeling "about the knee," thought the elephant seemed "very like a tree"; the fifth, "chancing to touch the elephant's ear," described him as being "very like a fan," and when within the scope of the sixth came the swinging tail, the fact that the elephant "is very like a rope" was to him proved beyond dispute.

And so these men of Indoostan
  Disputed loud and long,
Each in his own opinion
  Exceeding stiff and strong,
Though each was partly in the right,
  And all were in the wrong!

And now, if you will permit me to slightly alter the poet's last verse, so as to point the moral to our own selves:

How oft in scientific wars
  We disputants are seen
To rail in utter ignorance
  Of what each other mean,
And prate about an Elephant
  Not one of us has seen!

What is Research?

In this day of encyclopedias numerous and ponderous, one is often struck with the fact that in spite of the manifest care and conscientious thought bestowed by the responsible editors, the omissions and evidences of discontinuity of treatment, and lack of recognition of the prime purposes of the compilation are as noteworthy as the imposing array of the results of our steadily advancing knowledge is startling. For a philosophic treatment—one fully appreciative of that which the student really requires, not only to enlighten him with regard to a particular subject, but also to stimulate him to research where it is most needed—I frequently get more satisfaction out of the older encyclopedias than from our modern ones, even though they can but present the status of the subject up to the time they were written.

As an illustration, take the word "research," appearing in our topic of this evening, or any of the associated terms—"discovery," "experiment," "investigation" and "observation." Turning to the index volumes of the ninth and tenth editions of the "Encyclopedia Britan-

nica," I find but two references in which the word "research" appears —one to the exploring vessel, the *Research,* and the other to "research degrees." Turning to the page on which the latter occurs, we find this interesting statement referring to Oxford University:

> New degrees for the encouragement of research, the B.Lit. and B.Sc. (founded in 1895, and completed in 1900 by the institution of research doctorates), have attracted graduates from the universities of other countries. In 1899 a geographical department was opened, which is jointly supported by the University and by the Royal Geographical Society.

Now comes the interesting statement which I beg to emphasize:

> *Of more bearing on practical life are the Day Training College Delegacy (1892) and the diploma in education (1896). Under the former elementary school teachers are enabled to take their training course at Oxford, and do so in growing numbers,* etc.

We thus see what the writer of this article thinks of the relative value in practical life, of research foundations and normal school foundations! Yet we all know that this view is not typical of that held in a country having such productive research organizations as the Royal Society or the Royal Institution. Sir Norman Lockyer, in his luminous inaugural address before the British Association for the Advancement of Science, in 1903, on the "Influence of Brain-power on History," says: "A country's research is as important in the long run as its battleships." Why, then, does not the standard encyclopedia of that country make space for a representative article on "research"?

Under "investigation" there also appears absolutely nothing. However, we have the ship, "Investigator," Investigator Shoal, Investigator Group, etc., but not a word about the general methods employed by "scientific investigators." And so it is with the word "discovery"—there is no reference whatsoever to an article on the general principles leading up to discoveries. Likewise with the word "observation"; though there are many references to observations of various kinds, there is no one article for setting forth the general principles of "observations" or the part they play in the discovery of fundamental facts. The same experience is had with regard to the word "experiment."

Now let us turn to an encyclopedia I invariably read with pleasure and profit; it frequently has supplied me with references to earlier work not to be obtained elsewhere. We shall find it instructive to us to-night, though the articles to which I beg to invite your kind attention were written three fourths of a century ago. I refer to the classic Gehler's "Physikalisches Wörterbuch"—the revised edition by the noted investigators Brandes, Gmelin, Horner, Littrow, Muncke and Pfaff, in 20 volumes and published in Leipzig, 1825–1845. A veritable fund of information is found under the headings "Beobach-

tung" (observation) and "Versuch" (experiment). The article on "Beobachtung," by the physicist Muncke, embraces 28 octavo pages. He shows the distinction between "Beobachtungen" (observations) and "Versuche" (experiments) to be that the former pertain to the perceptions of phenomena presented to us by nature in her unmodified course, whereas in the latter—in the experiments—we are seeking to produce certain results or phenomena, more or less looked for, in order either to verify a law already known or to disprove one suspected of being wrong or even to discover a new one. Both classes of experiences are necessary for a piece of investigation or research work.

Thus, we may behold either visually or in some other way certain striking solar phenomena; these belong to the class of observations which we ourselves are unable to modify in any manner whatsoever. Continued observation may, however reveal a certain law which by experiment in the laboratory, conducted along more or less definite lines, we may seek to imitate in the hope of getting some clue to the *modus operandi* of the observed phenomena. In this article on "Observations" the author treats in detail the various elements entering into correct methods of investigation, condition of the observer and of his senses, his being unbiased, character and errors of the instruments, errors of results, methods of increasing accuracy, representations of observations by graphs and formulæ, method of least squares, etc. He points out the mistake sometimes made, that an established formula satisfying the observed phenomenon within certain limits represents an actual law of nature.

The article "Versuch" (experiment) consists of 44 pages and is contributed by the astronomer Littrow. He shows that the most rapid development takes place in those sciences which afford the greatest opportunity for experimentation, referring, *e. g.*, to the slow and painful progress of the astronomer as long as he had to confine himself to mere celestial observations and the comparatively rapid strides which occurred as soon as some of the observed phenomena could be either imitated by, or be compared with, those derived by laboratory experiment. The investigator, he says, must be absolutely free from preconceptions and be careful, cautious and unbiased in his interpretation of what his senses may reveal to him. He illustrates how man, called jokingly "das Ursachenthier" (the animal ever bent on ascertaining the cause of things), proceeds in ferreting out the why and wherefore of observed phenomena, and how his methods of circumspection develop with the advance of knowledge.

Though man can not determine the "Endursachen," or ultimate causes of things, the field open to him to discover the laws governing phenomena or, *vice versa,* classifying and enumerating those which

follow a certain revealed law, is, nevertheless, still very large and sufficient to tax his energies. Witness, for example, the host of observed phenomena obeying the law of inverse squares!

The remaining sections of Littrow's article deal with the reduction of the experiments to the laws of motion, the numerical expression of the observed results in definite units, the importance of the part played by instruments or mechanical appliances, derivation of laws governing the observations, methods of ascertaining these laws, methods of reduction and of publication, and errors to be avoided.

These two articles will show sufficiently the character and scope of similar ones we should like to see in our standard English and American encyclopedias.[2] Such information is contained in some measure, at least, though not as comprehensively, in the modern German book of reference, Brockhaus's "Conversations-Lexikon," as also in the "Grande Encyclopedia" of the French. It is truly remarkable that there should be such an oversight in our "International Encyclopedia," when it is remembered that the editor-in-chief was one to whom research work owes a very great debt of gratitude indeed—the late and greatly lamented Daniel Coit Gilman. The only article found is one on "expert," and this pertains chiefly to "expert evidence" in courts of law. Yet what better statement concerning the "research or scientific spirit" could be made than contained in the following quotation[3] from Gilman's writings?

> It is perpetually active. It is the search for the truth—questioning, doubting, verifying, sifting, testing, proving, that which has been handed down; observing, weighing, measuring, comparing the phenomena of nature, open and recondite. In such researches, a degree of accuracy is nowadays reached which was impossible before the lens, the balance, and the metre, those marvelous instruments of precision, had attained their modern perfection. Wherever we look we may find indications of the scientific spirit. The search after origins and the grounds of belief, the love of natural history, the establishment of laboratories, the perfection of scientific apparatus, the formation of scientific associations, and the employment of scientific methods in history, politics, economics, philology, psychology, are examples of the trend of intellectual activity. The readiness of the general government and of many State legislatures to encourage surveys and bureaus, the establishment of museums of natural history, and the support of explorations illustrate this tendency. Even theology feels the influence. The ancient and sacred proverb has been rediscovered —the letter killeth and the spirit maketh alive. I will go only to the edge of this disputed territory and shelter my own opinions behind those of a learned devout prelate of the English Church (Bishop Walcott), whose words are these: "No one can believe more firmly than I do that we are living in a time of revelation, and that the teachings of physical science are to be for us what Greek literature was in the twelfth century." . . .

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[2] "Chamber's Encyclopedia" is found to contain a short article on "Experiment"; also one on "Observation."

[3] Extracts from the "Launching of a University," 1906, pp. 147–150.

With the growth of the scientific spirit grows the love of truth, and with the love of truth in the abstract comes the love of accuracy in the concrete.

Our foremost English dictionaries are in general not any more satisfying or edifying regarding the precise meaning of "research" in the scientific sense than are the standard encyclopedias. Their illustrations of the use of the word are usually neither apt nor sufficiently comprehensive.

How may we sharpen Our Senses?

Of the senses, *sight* plays the greatest part in investigation. To this organ we have thus far devoted most attention to supplement and increase its natural powers by mechanical means—the telescope, microscope, etc. Next would rank the sense of *hearing;* but the appliances for increasing our sensations in this respect are comparatively few, and still more is this the case with regard to the senses of *taste, smell* and *touch.*

Yet what truly wonderful powers of touch are developed by the blind, and how extraordinary are the capabilities of certain animals for foretelling the distant approach of a deadly foe by the means of hearing or of smell! There are well-authenticated cases on record where animals unquestionably appear to have "felt" the coming of a great natural catastrophe, like an earthquake, several hours before any human being had the same knowledge.

Might not man also, to his advantage, increase or stimulate his less-used senses in some manner, to the same degree or approximately so, as that of sight? If he did, is it not possible that thereby he might have perceptions which would materially assist him in solving some of the vexed riddles of the universe? May he not, for lack, of proper development of these senses, be in much the same plight as the "six men of Indoostan to learning much inclined who went to *see* the elephant, though all of them were *blind*"?

If there is some possibility in this direction, how about the power of stimulating or interpreting our muscle sensations, the sensations of heat and cold, of pain, of pleasure, etc.? Efforts have been made, as you know, to trace a definite connection between certain atmospheric phenomena and bodily sensations, or between the impelling motives to commit suicide or other crimes and certain meteorological conditions. Likewise are there attempts by well-known men of science to sharpen and interpret the psychic sensations.

There is revealed here a field of research but little explored as yet —the increase of our powers of perception along other lines than chiefly those of sight. No one can foretell the future possibilities in these directions.

The doctrine of evolution teaches the result of long-discontinued

use of any particular organ, and has familiarized us with the wonderful achievements of nature brought about by sustained and continued effort along some definite direction. Both the physical and the psychic conditions of the observer require their highest and healthiest development to insure not only the best results with the ever-increasing accuracy or precision required by the steady advance of knowledge, but also to bring about that round- or broad-mindedness needed for the proper interpretation of the results observed.

The Mathematical Instruments of Research

A good-sized chapter might be written on the "Mathematical Instruments or Tools of Research." The predominating tendency of resolving or expressing every natural phenomenon—periodic or otherwise—by a Bessel or a Fourier series or by spherical harmonic functions has brought about at times, especially in geophysical and cosmical phenomena, if not direct misapplications, at least misinterpretations of the meaning and value of the coefficients derived. Like a certain class of "naturalists," we also may have laid ourselves open to the approbrious term of "nature-fakir," and instead of clarifying the situation our calculations may have actually contributed instead to "befog" it.

Frequently by the purely mathematical process there have been eliminated, in the attempt to represent a more or less irregularly occurring natural phenomenon by a smoothly flowing function, the very things of chief and permanent interest. The normal or average diurnal temperature curve, for example, or a uniform magnetic distribution over land, so as to yield perfectly regular lines of equal magnetic declination, never occurs in nature. There is thus being impressed upon us more and more forcibly the fact that what we have been regarding as "abnormal features"—the outstanding residuals between observations and the results derived from the mathematical formula—are in truth not "abnormal" from the standpoint of nature, but are rather to be taken as indicative of the "abnormality" or "narrow-mindedness," which means the same thing, of ourselves in trying to dictate to nature the artificial and regular channels she should pursue in her operations.

Louis Agassiz said:

> The temptation to impose one's own ideas upon nature, to explain her mysteries by brilliant theories rather than by patient study of the facts as we find them, still leads us away.

The fundamental law of nature is to invariably follow the paths of least resistance, and by examining these lines of structural weakness of the opposing systems we may have opened to us the very facts which are to be of real value and of sure benefit to mankind.

The irregularity of the banks bordering a natural watercourse serves to differentiate the work of nature from that of the builder of the artificial and regular channel.

No, instead of rejecting, we must learn to retain the outstanding residuals and study them most carefully and regard *them* as the true facts of nature, and not those which we so egotistically and presumptuously try to force on her. What great discoveries may lie open to us when we once have grasped the true significance of the facts we have been so fond of measuring by our own standard and have been terming as "abnormal" or "irregular"!

An interesting example of not wholly successful application of the continuous and ever-recurring functions of spherical harmonics to a typical geophysical phenomenon—the distribution of magnetism over the earth's surface—has been discussed by the speaker elsewhere. Though the number of unknowns has been increased in recent computations from the original 24 of Gauss to 48, nevertheless the difference between theory and observation is of such an order of magnitude as to preclude the use of the formula for even the purely practical demands of the navigator and surveyor. Nor has any one succeeded in giving any physical interpretation of the laboriously derived coefficients beyond the first three. And what do these three stand for? The simplest possible case of a first approximation to the actual state of the earth's magnetism, *viz.*, that of a uniform magnetization about a diameter inclined to the axis of rotation!

The prime difficulty here may be summed up in a word. The very surface over which the spherical harmonic functions are spread is itself such a prolific source of disturbance as to cause effects embracing a continent, a state or a locality. Such a large number of terms would be requisite for an adequate representation as to make their computation prohibitive. We are dealing here with more or less non-continuous effects that cannot be imitated by continuous functions without leaving behind a train of residuals, precisely as though we were to try to fit to the actual configuration of the earth some standard pattern of our own. Let me ask what phenomenon have we, in fact, which will admit of the determination of 48, or even of 24, physical constants?

It had been my intention to say a few words on the value and limitation of that much-used as well as abused mathematical instrument of research, the method of least squares. Properly employed, it is a most useful adjunct to investigation; but, as intimated, the true significance of formulæ established by this method is at times pushed far beyond the limitations. What the tenor of my remarks might be will be sufficiently evident to you if I submit this query for

your consideration: *What actual laws of nature have been discovered by the method of least squares?*

The Mechanical Instruments of Research

A few minutes were to have been given to the instruments employed by the scientific man to sharpen and amplify his natural senses and sensations—in a word, the tools furnished him by the mechanician. I am glad, however, both for your sake and mine, that this part of the subject was covered by an interesting paper presented at the previous meeting of the society. It was emphasized there that for the best results it is essential that the investigator be able to work with instruments so constructed as to permit him to control or renew the various adjustments without the necessity of returning the instrument to the maker. The principle at times employed, which assumes that when adjustments are once made they are to "remain put," is apt to prove a very pernicious one. A number of very interesting examples from my own experience in the purchase of magnetic instruments during the past ten years might be cited; but, as has been said, this part of the subject having already been covered, there is no need to dwell further upon it than to emphasize the injunction that the research worker, if he desires the best results, must know his instruments as thoroughly as himself.

Subjects of Research

We come next to a brief consideration of the *subjects* of research, though not specifically mentioned in the title of our paper, yet implied in it. The rapid progress made by a science as soon as it reaches the stage of experimentation has already been noted. A crucial experiment has at times furnished information which by mere observation of phenomena, running their natural and unmodified course, might either have never come into our possession or at best would have taken a considerably longer time than that of the decisive experiment. You are all familiar with such cases, for almost every science can furnish examples.

Now it is an extremely interesting and suggestive fact that the greatest experimental discoveries to-day are not made in the older, well-recognized sciences, but on their borderlands—in the "twilight zones" of more or less related sciences. I have but to mention the words "physical chemistry," "physical geology," "astrophysics," "biochemistry," etc., and you will readily grant the assertion made. In the overlapping regions there seem to be the greatest opportunities afforded for solid, thorough, and at the same time remarkably rapid, experimental achievements. And so we are having produced almost daily new specialties or new sub-specialties.

What is the effect on the general broad-mindedness of man by this extreme specialization, so necessary for the production of the best and most far-reaching results? *Is the modern specialist more narrow-minded than the generalist of a century or two ago?* In view of our opening statement that the prime instrument of research is, after all, the mind, the question is, as you see, not an irrelevant one. We find statements occasionally made which would imply an affirmative answer to our question; but I, for one, would most emphatically protest against such an inference. I should maintain that the specialist, other things being equal, is likely to be a broader man than he who has no specialty, but simply a general knowledge of some particular science. The reason for my positive statement would be found in the fact mentioned, that the greatest part of the research work to-day is being done on the border-lands of the general sciences; for he who wishes to take part in this very active competition must needs be far better equipped than the mere generalist. The physical chemist, to be most successful, must have a very intimate knowledge of both physics and chemistry, and the more mathematical skill he possesses the better. The astrophysicist must be a physicist, a chemist, a mathematician, besides being an astronomer. And so with regard to the geophysicist.

Only a few names need be cited—like those, for example, of Faraday, Maxwell, Kelvin, von Helmholtz, Mascart—to support the contention that the broadest physicists are, as a rule, those who have regarded their laboratory experiments and deductions therefrom merely as a means to an end, not an end in themselves, and who have accordingly sought to apply the knowledge gained to the solution of some of the great problems affecting the general welfare of man. There is the greatest need in this country of well-trained and well-equipped physicists in the solution of the many perplexing problems of the earth's physics with regard to the phenomena of seismology, vulcanology, meteorology, geodesy, atmospheric electricity, terrestrial magnetism, etc. When the investigator makes the attempt to apply some of his laboratory facts to geophysical and cosmical phenomena, he has opened to himself a world of which he never dreamed; he finds zest in familiarizing himself with the fundamental facts of other sciences in which until now he could take no interest.

Methods of Research; Discovery of Laws

The methods in general have already received treatment in connection with the foregoing topics. It is always interesting to know what was the precise course followed in the discovery of a great law. However, no two investigators have ever pursued, or at least but rarely, precisely the same paths, and we must therefore be content with the

statement of the general principles of research, such as has already been given.

A prevalent fault is observed in scientific publications whenever the investigator has had good training only on the observational side and but very little experience in scientific computing. He is very apt to violate one of the first and fundamental principles of good observing, *viz., to employ such a method or scheme of observing as will yield but one definite result, and that with the highest possible accuracy and with the least amount of computation.* Oftener than may be thought, schemes of observation are used which leave an arbitrary element to the computer, and in consequence a different result is forthcoming, according to who makes the computation. Had we time apt illustrations could readily be given from published works. *The point made, that the observer must also bear in mind the computation side, and work up his results as soon as possible, is of fundamental importance in research work.*

It may be worth while to consider briefly the insatiable desire of the analyst to "ring" in a series of sines and cosines to resemble the course of some natural phenomenon of which he does not know the exact law. Is this the old story over again, though in somewhat altered garb, of the epicycles and deferents of ancient astronomical mechanics, which received its highest development in the Ptolemaic System of the Universe? You will recall that Ptolemy, building on the suggestions of Appollonius and Hipparchus, supposed a planet to describe an epicycle by a uniform revolution in a circle whose center was carried uniformly in an eccentric round the earth. By suitable assumptions as to his variable factors, he was thus able to represent with considerable accuracy the apparent motions of the planets and to reproduce quite satisfactorily other astronomical facts. This was the artifice employed by the astronomer of the period before the modern and more subtle art of simulating nature, by the sine-cosine method, had become known.

What seemed so intricate and complex in Ptolemy's time could be expressed in very simple language indeed, when a Kepler discovered the true functions as embodied in his three fundamental laws. The present method of hiding our ignorance of the real law, which seems at times to exert such a mesmerizing influence over us as to make us mistake the fictitious for the real, reminds one of the old conundrum: "Patch on, patch on, hole in the middle; if you guess this riddle, I'll give you a golden fiddle." If the sine and cosine of the angle does not represent the curve of observation, patch on a sine and cosine of twice the angle; then, if necessary, thrice the angle; next, four times, and so *ad infinitum!* Now guess the riddle!

Of course I do not mean to discard this useful and in fact indis-

pensable tool of research, but simply wish to call attention to its limitations and to the importance of not overlooking the fertile by-products, the residuals which, because of our neglect of them, may some day rise and smite us in their wrath. Each one of us at one time or another has doubtless established, by least squares, an empirical formula of some kind which so beautifully fits the observations as to make us bold and venturesome. Now comes a new observation, somewhat outside of the range for which the expression was established. Eagerly the test is applied, and we find, to our chagrin, that the formula on which so much work had been spent will not fit the new result, and that we have a "counterfeit" and not the real law.

A graphical process, like the crucial and decisive experiment, may at times reveal an essential fact that the mind of even the greatest of mathematicians has failed to extract from his formulas.

Let us suppose, for illustration, we are dealing with a phenomenon which almost entirely unfolds itself during the time between sunrise and sunset—the well-known diurnal variation of the earth's magnetism is a striking case of the kind. Following the usual method, the phenomenon is resolved into component parts with the aid of a Fourier series. The formula as generally adopted includes the four terms having, respectively, periodicities of 24, 12, 8 and 6 hours. For ordinary magnetic latitudes the striking result is obtained that the second term—the 12-hour one—is as important as the first, or 24-hour, one; so we might equally as well say "the semidiurnal" as "the diurnal variation of the earth's magnetism." In fact, as the semidiurnal term unfolds itself twice in 24 hours, it is in reality more important than the purely diurnal one.

Does the resolution into Fourier terms of a phenomenon of the kind given really prove their existence in nature? Can we conclude without question that in addition to the diurnal term we also have a semidiurnal one? Even with four terms, the series does not represent each hourly observation of the 24 with the same degree of precision. In fact, the residuals for the night hours are nearly of the same order of magnitude as the observed quantities. If the physical existence of the 12-hour term is not proved, then there is no need of racking our brains as to its physical origin.

The difficulty disclosed by this example is of the same kind as the one treated in spherical harmonics, *viz.*, that we are attempting to represent a more or less non-continuous function having a duration commensurate with that of the daylight hours by functions running smoothly through their individual courses for 24 hours.

Babbage, the inventor of the calculating machine named after him, said he once had the following question put to him: "Pray, Mr. Babbage, if you put into the machine wrong figures, will the right

answer come out?" Do we not at times attempt to put wrong premises into nature's machinery and then expect correct answers?

We can not close this section better than by quoting the following passage from the address of the first president of this society, Joseph Henry, given on November 24, 1877:

> The general mental qualification necessary for scientific advancement is that which is usually denominated 'common sense,' though, added to this, imagination, induction, and trained logic, either of common language or of mathematics, are important adjuncts. Nor are the objects of scientific culture difficult of attainment. It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

Henry's insistence on the application in our scientific work of "common sense" reminds one of Clifford's apt definition of science as being "organized common sense."

Publication of Results of Research Work

We come next to the question of publication of the results of research. I think it may be taken as almost axiomatic that whatever is worthy of investigation should be made known in some effective manner, so as to reach without question those concerned. The multiplicity of literature on any one subject or even on any small portion thereof is nowadays such that the worker finds it utterly impossible to keep abreast of publications, even those in his own field, to say nothing of kindred ones.

He is forced more and more to rely on abstracts—at least in so far as to direct him to that which he unquestionably must consult in the original, if possible. In my own particular line of work I rarely find that an abstract supplies all that is needed, and I almost invariably prefer to work directly with the original. I have heard similar statements from workers in other fields.

If it be true, then, that the investigator usually finds it necessary to consult the original publications, the next conclusion to be drawn is that the publication of any research work should, in general, be of such form and size as to permit the widest distribution possible, not only among the libraries and the principal seats of learning, but also among the workers and institutions immediately interested.

The scientific worker generally does not possess the means to purchase or to construct the instruments he requires for the prosecution of his work, and a book bearing in any way on the line of work to be pursued is as much to be considered part of his equipment as the purely mechanical tools. Indeed, I was told by the late von Bezold that Wilhelm Weber set his laboratory students to work by telling them, "Here are the instruments, and there are the *Annalen der Physik;* now go to work." The man of science usually wants his

tools close by and within ready reach. He cannot afford to go to a distant library and then possibly find the book out. Private possession permits him, furthermore, to make marginal notes and references to enable him quickly to put his finger on the very thing needed.

Owing to these well-organized needs, there has grown up a courteous and friendly interchange of publications among coworkers and sympathizers in the same field that to my mind deserves the highest encouragement. The time has unfortunately gone when scientific investigators can write such delightful and voluminous letters as passed between the research workers of half a century and more ago. The present system of interchange of publications has necessarily taken the place, to a very large extent, of the early letter-writing. It is a system of gradual development along the lines of least resistance that it would be disadvantageous to contend against until some more effective means of intercommunication among scientific men has been devised.

But such free interchange of research publications can only be conducted to a limited extent and can embrace only certain kinds of publications, *viz.*, generally reprints or those of which the original cost for publication has already been borne in some manner, be it by a journal or by some research foundation. Larger publications, however, because of their expensiveness, must generally be restricted, for one reason or another, in their general circulation, with the inevitable result that the persons directly reached may be entirely out of proportion to the importance of the work undertaken.

Scientific men and scientific bodies could well afford to pause and consider the tremendous cost of publication and the rather frequent waste of money incurred. Why is it, for example, that when an explorer gives an account of his travels in an unexplored region for the commercial press he finds it possible to say what he wishes in an attractive and handy octavo form, but when he is working for an endowed institution he feels compelled to present his matter in an expensive, ponderous, quarto form, inconvenient to handle?

It should be noted that it is as important to make research work known as to do it. To get our friends to read the contributions we may make to science requires nowadays no little skill and diplomacy and an attractiveness of literary style on the part of the author not so essential in the days of less frequent printed works. The original purposes of important and costly expeditions are sometimes well nigh defeated or superseded, because of the delay in publication, ensuing from the elaborateness of the plan adopted for the reduction of the field results and the form of publication decided upon.

Reduction in the pretentiousness, size and cost of scientific publications appears to me to be one of the greatest needs of research to-day.

Methods of Research by Institutions

Some time could profitably be spent on a consideration of the general agencies engaged in furthering research work and the methods employed for doing so. Being, however, connected with a "research institution," I should consider myself incompetent to enter upon a free and unbiased discussion of the methods of such organizations for the furthering of research work. Suffice it to say that it appears sometimes to be overlooked that *the most valuable asset of a research organization is the research spirit of its workers,* without it no amount of funds could accomplish the desired end. My remarks will be chiefly confined to a brief discussion of the methods to be used in certain investigations of a world-wide character. Craving your indulgence once more, I shall take as an example the general magnetic survey of the earth as representative of the kind of world-embracing research enterprises I have in mind.

Alexander von Humboldt, whose mental grasp was extraordinary in more than one science, set forth the following plan in his "Cosmos" for a general magnetic survey of the globe.[4]

> *Four times in every century an expedition of three ships should be sent out to examine as nearly as posible at the same time the state of the magnetism of the earth, so far as it can be investigated in those parts which are covered by the ocean. . . . Land expeditions should be combined with these voyages. . . .*
>
> *May the year 1850 be marked as the first normal epoch in which the materials for a magnetic chart shall be collected, and may permanent scientific institutions (academies) impose upon themselves the practise of reminding, every twenty-five or thirty years, governments, favorable to the advance of navigation, of the importance of an undertaking whose great cosmical importance depends on its long continued repetition.*

Here was a noble project, universally conceded to be not only of the greatest scientific interest, but also of the greatest practical importance. Yet why is it that this grand plan has never been carried out by the foremost nations in friendly concert? Have our academies, as Humboldt suggested, never "imposed upon themselves the practise of reminding every twenty-five or thirty years governments, favorable to the advance of navigation, of the importance of an undertaking" of this character?

Instead of working along a common and definite plan, the magnetic operations hitherto have consisted of more or less isolated and incomplete surveys, independently undertaken by various nations and distributed over a great number of years. Not even for a single epoch has it been possible to construct the magnetic charts on the basis of homogeneous material, distributed over the greater part of the earth, with some attempt, at least, at uniformity. And as to the possibility of

[4] The quotation is from E. C. Otté's translation of the "Cosmos," vol. II., pp. 719–720.

constructing the charts, with the aid of similar data, for epochs twenty-five or thirty years apart, as Humboldt had dreamed, this, in spite of the enlightened interest of many countries, is even more remote.

Why should it have remained for a purely *research* organization to undertake a problem touching so keenly, as this, on even the so-called sordid, highly practical interests of man? It is a fortunate fact that Humboldt's fascinating international scheme failed of execution, and that the chief brunt of the work is now being borne by a single organization? It is not for the speaker to attempt to answer. The magnetic work of the Carnegie Institution of Washington has embraced, since 1904, a general magnetic survey of the Pacific Ocean, and land observations have been made in more or less unexplored regions in different parts of the world. The ocean magnetic work is to be undertaken next in the Atlantic Ocean, in 1909, on a specially built vessel, the first of its kind.

It is believed that an effective scheme of operation has been evolved, with the aid of the valuable advice received from eminent investigators. Without danger of giving offense to any one, it is possible to deal directly with the officials concerned, submitting to them our plans and ascertaining whether they contemplate doing anything similar, and, if so, whether, in case their funds are insufficient, they could suggest some friendly basis of cooperation between their organization and ours. This plan of action has met with entire success thus far. Duplication, overlappings and possible jealousies are all avoided; and in countries where no organization whatever exists to do the work, we are free to go ahead and finish the task in less time than it would necessarily take to get an official action or official consensus of opinion from a large scientific body.

Slow deliberation in terrestrial magnetic work would be disastrous, for the prime reason that the phenomena of investigation in this field of research are continuously undergoing change. The time-element in the earth's magnetism, even for a period of a few years, is of such moment as to completely mask the fine, hair-splitting points which would necessarily and rightly have to be raised on some international mode of action, to say nothing of the painful and cumbersome method which would have to be employed to conform with the rules of official correspondence between nations. Many a well and carefully executed magnetic survey in the past has had its full importance for world-wide investigation destroyed because of the possibility of error in the secular variation corrections which must be applied to bring its results up to date.

Though I may be judged guilty of defending my own policy, I believe the course pursued by the Carnegie Institution of Washington in conducting the general magnetic survey of the globe is the only

way in which this particular project, and similar ones to it, could not only be expeditiously conducted, but so as to realize the chief objects of the work. Judging from individual expressions received from scientific men everywhere, they appear in agreement with us. This policy, briefly stated, is: To make, with the aid of the friendly and harmonious cooperation of all concerned, a rapidly executed magnetic survey of the greater part of the globe, so that a general survey, all-sufficient for the solution of some of the great and world-wide problems of the earth's magnetism, will be completed within a period of ten to fifteen years. At a smaller number of points, selected in consideration of the prime questions at issue, the observations are to be repeated at intervals of five years or less, in order to supplement the rather sparsely distributed magnetic observatory data. Thus the determination of the corrections for reduction of the general work to any specific date is continuously provided for.

Now, had I the time or were this the place, I should like to add a paragraph regarding the needful accuracy and the prime questions to be considered in the conduct of such a piece of work. Permit me to say that the most evident result of all magnetic work in the past is that, for the purposes of a general survey, it is far better to make some sacrifice in accuracy if thereby it is made possible to secure observations at another point. In other words, the errors due to local disturbing conditions are far greater than the purely observational ones. *Hence multiplicity of stations rather than extreme accuracy and laborious methods of observation and reduction is the prime requisite in magnetic survey work.*

Stimulants to Research Work

Dr. Gilman, in his charming reminiscences of the non-resident lecturers of the Johns Hopkins University, related the following of the great mathematician Sylvester:

> Sylvester enjoyed stimulants—I do not mean such vulgar and material articles as alcohol and coffee. I never saw any indications that he cared for their support. But he loved such stimulants to intellectual activity as music and light, lively society, in which he was not called upon to participate. Once at a symphony concert I sat just behind him, admiring the dome of his capacious cranium, unconcealed by hair, and I noticed how absorbed he was. The next day, Sunday, he came to me impetuously to say that he had worked out some mathematical proposition at the concert of the evening before, the music having quickened his mathematical mind. He really thought this was his greatest achievement yet, and he had hastened to write it out and mail it to the Academy of Sciences in Paris. Once he told me that, having a special paper to prepare, he went to a store and bought a pound of candles, which he placed about his room, on all sorts of extemporaneous candlesticks; "for light," he said, "is a most powerful tonic."

These anecdotes will serve to recall similar ones of noted men,

and many of you, doubtless, were this an experience meeting, could easily occupy the balance of the evening in delightful recollections of what each has found best to stimulate him to renewed intellectual activity; and I dare say that many of you would unite with me in declaring that membership in this society has been one of the most helpful and stimulating influences.

We really have much to be proud of in the history and membership of the Philosophical Society of Washington. I should, indeed consider myself remiss in the duties imposed upon me by the subject selected did I not refer at least to the eminent part this society, through its members, has taken in bringing about the wonderful appreciation of scientific work and scientific methods we are to-day witnessing in our country. There have been several notable addresses by past presidents that might advantageously have been reviewed in connection with our topic. But we lack the time.

I cannot refrain, however, from quoting once more from Henry's address, already referred to, which I hope you may be induced to read in its entirety:

> **Man is a sympathetic being, and no incentive to mental exertion is more powerful than that which springs from a desire for the approbation of his fellowmen; besides this, frequent interchange of ideas and appreciative encouragement are almost essential to the successful prosecution of labors requiring profound thought and continued mental exertion. . . .**
>
> **It is an essential feature of a scientific society that every communication presented to it should be subject to free critical discussion. Such discussion not only enlivens the proceedings, but is generally instructive, frequently eliciting facts which, though insignificant when isolated, when brought together mutually illustrate each other and lead ultimately to important conclusions.**

Conclusion

My address began with statements revealing the necessity of keeping our minds ever open and free for the careful weighing and the unbiased reception of the facts observed and discovered. Throughout I have attempted to lay chief stress upon the mental and human elements involved in the topic. I can not do better in closing than to quote you a sentence from a letter[5] which the great mathematical physicist, James Clerk Maxwell, wrote to Herbert Spencer on a subject of controversy in the latter's "First Principles," *viz.:*

> **It is very seldom that any man who tries to form a system can prevent his system from forming around him, and closing him in before he is forty. Hence the wisdom of putting in some ingredient to check crystallization and keep the system in a colloidal condition.**

Let our watchword therefore be: *ever to keep our systems—our theories—in a colloidal condition!*

[5] "Life and Letters of Herbert Spencer," by David Duncan, Vol. II., p. 163.

DR. DAVID STARR JORDAN,

President of Leland Stanford Junior University and President-elect of the American Association for the Advancement of Science.

THE PROGRESS OF SCIENCE

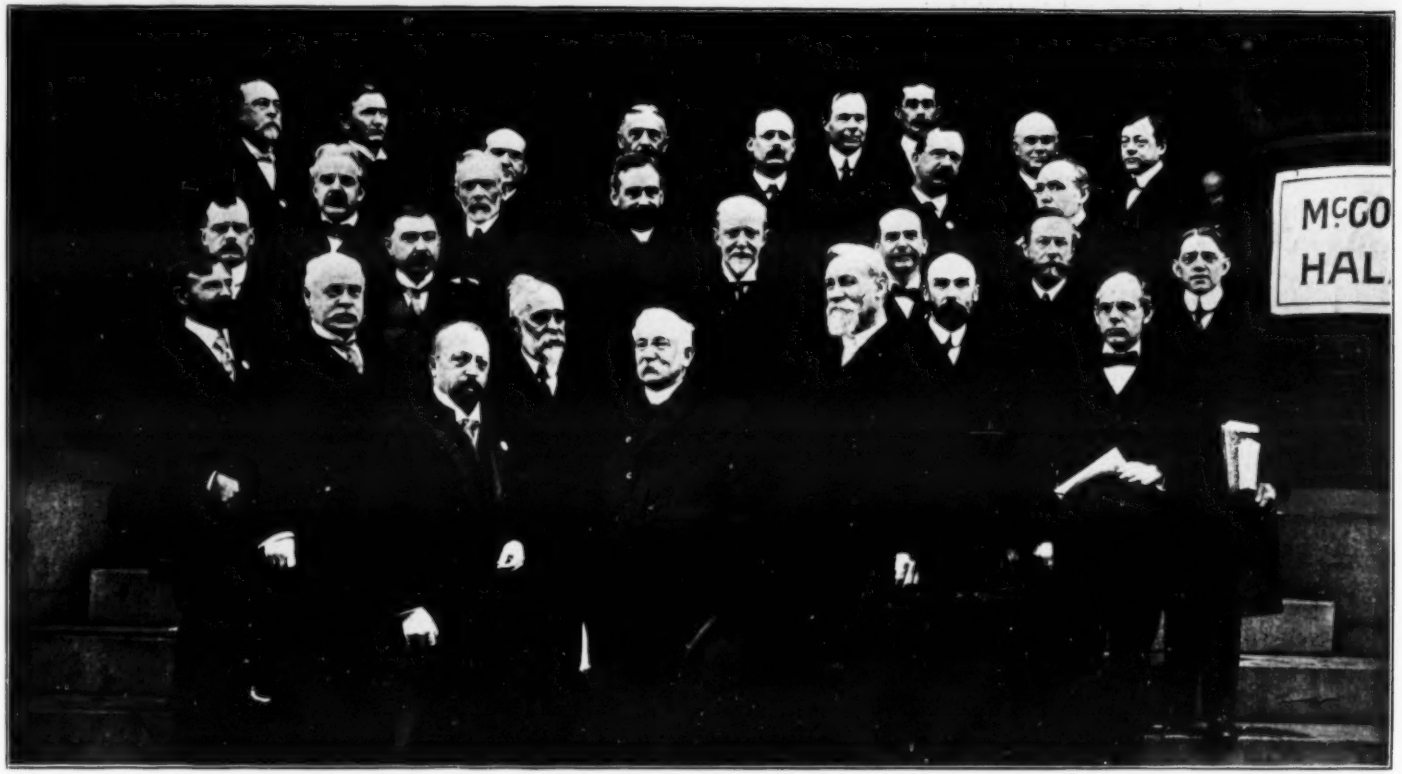
THE SCIENTIFIC MEETINGS AT BALTIMORE

THE meetings of the American Association for the Advancement of Science and the affiliated national scientific societies held at the Johns Hopkins University during convocation week brought together more than two thousand scientific men and their programs contained the titles of more than one thousand scientific papers. Such a gathering has not occurred elsewhere or hitherto, and it is encouraging to see demonstrated in this public way the fact that this country is now taking the place in scientific research warranted by its population and its wealth. The meeting is not only an exhibition of what has been accomplished; it is also a stimulus in further efforts. The scientific men who come together from all parts of the country to present and discuss the results of the year's work return to their institutions with more knowledge and renewed zeal. It would be worth the while for each of our thousand colleges —and the smaller and more remote they are the more worth the while— to pay the expenses of delegates to a meeting of this kind. This would be no less useful or profitable than to supply books or apparatus. Dartmouth College set this year a precedent, making an appropriation of $300 to send nine representatives to the meeting.

The arrangements by the local committee worked so smoothly and the meeting places of the groups were so separated that it was difficult to realize fully the magnitude of the meeting except by reference to the program. In it one found some seventy pages devoted to a mere list of the papers to be presented and a great array of general meetings, public lectures, dinners, smokers, etc. From this vast mass of material only a few events can be selected for mention.

At the opening meeting on the morning of December 28, the retiring president, Dr. E. L. Nichols, professor of physics at Cornell University, introduced the president of the meeting, Dr. T. C. Chamberlin, professor of geology at the University of Chicago, and the association was welcomed to Baltimore by the mayor of the city, by Dr. Ira Remsen, president of the Johns Hopkins University, who presided at the first convocation week meeting in Washington six years ago, and by Dr. William H. Welch, chairman of the local committee and professor of pathology in the Johns Hopkins University, who presided at the New York meeting two years ago.

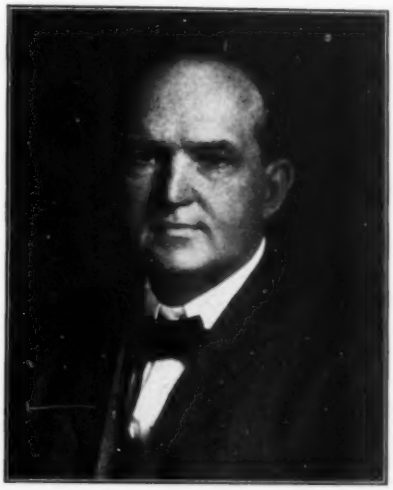
In the evening the retiring president gave his address, which was an admirable survey of the place of science in modern civilization and an impressive plea for more research work and greater freedom in our universities. All the vice-presidential addresses before the sections of the association and the presidential addresses before the special societies maintained high scientific standards, and some of them were of broad general interest. Among the lectures may perhaps be selected for mention the addresses by Mr. G. K. Gilbert, of the U. S. Geological Survey, on earthquake forecasts, which had a sad and dramatic timeliness; by Major Squier, U.S.A., on the remarkable recent progress in navigating the air by means of dirigible balloons and aeroplanes; by Mr. Bryan, on Mt. Kilauea, whose address was beautifully illustrated and of special interest in view



MEMBERS OF THE COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

At the front are: Dr. Wm. H. Welch, Chairman of the Local Committee and Past President of the Association; Dr. L. O. Howard, Permanent Secretary; Professor Charles E. Bessey, retiring Vice-president for the Section of Botany; President R. S. Woodward, Treasurer and Past President; and Professor T. C. Chamberlin, President for the Baltimore meeting.

of the probable meeting of the association in Honolulu eighteen months hence; by Professor Wilson, of Columbia University, describing the classic researches made by him and others on the determination and heredity of sex; by Dr. Brown, U. S. Commissioner of Education, who spoke with authority on world standards of education; by Professor Penck, of Berlin, eminent as a geologist and geographer, who lectured on man, climate and soil, and by Professor Poulton, of Oxford, the leading authority on natural selection,

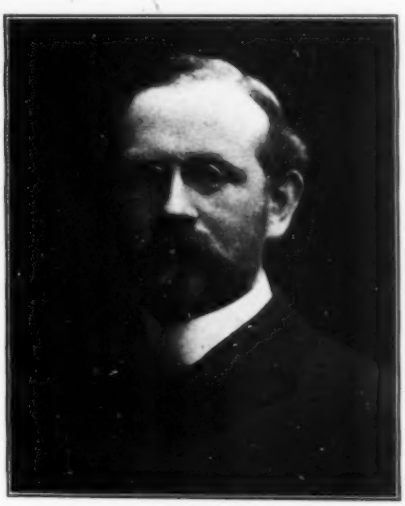


DR. C. J. KEYSER,
Adrian Professor of Mathematics in Columbia University, Vice-president for the Section of Mathematics and Astronomy.

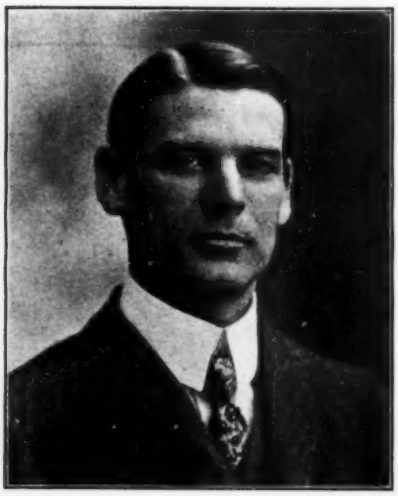
DR. LOUIS KAHLENBERG,
Professor of Physical Chemistry in the University of Wisconsin, Vice-president for the Section of Chemistry.

whose subject was mimicry in the butterflies of North America.

In addition to the great number of discussions and special sessions, two memorial meetings were of striking significance. The former students and colleagues of William Keith Brooks, professor at the Johns Hopkins University from its establishment in 1876 to his death, two months ago, met to do honor to his memory. No fewer than sixty joined in a dinner on the last day of the old year, and their numbers and standing not less than their words bore witness to the great influence exerted by Brooks on the development of the biological sciences throughout the country. The last day of the meeting and the first day of the new year was devoted to a Darwin



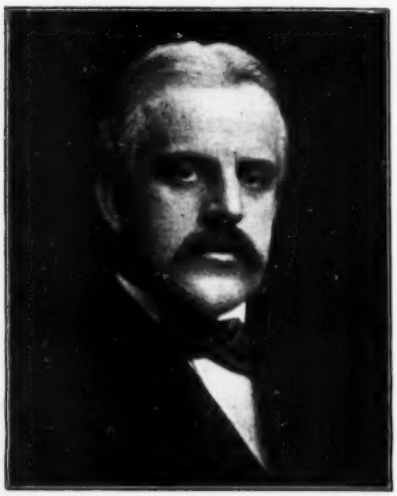
DR. CARL E. GUTHE,
Professor of Physics in the University of Iowa, Vice-president for the Section of Physics.



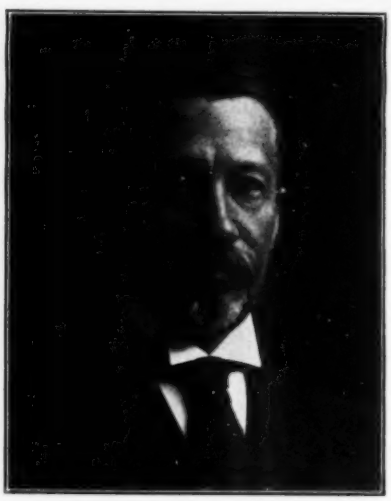
DR. C. JUDSON HERRICK.
Professor of Neurology in the University of Chicago and Vice-president of the Section of Zoology.

memorial, celebrating the hundredth anniversary of his birth, which occurs on February 12, and the fiftieth anniversary of the publication of the origin of species. Professor Poulton, who came from England to take part, gave a vivid account of Darwin's work and influence. He was followed by a number of leading American investigators of problems of organic evolution whose papers gave an excellent survey of present conditions, showing both the dependence of modern biological science on Darwin's work and the new problems which have now come to the front.

Dr. David Starr Jordan, president of Stanford University, eminent as an ichthyologist and as a student of a wide range of evolutionary problems and equally for his services to education and civilization, was elected president for the meeting to be held next year in Boston. The vice-presidents of the Baltimore meeting were worthily succeeded by a group of men who represent the best scientific work now being done in this country. They are: *Mathematics and Astronomy*—Professor Ernest W. Brown, Yale University. *Physics*—Dr. L. A. Bauer, Carnegie Institution, Washington, D. C. *Chemistry*—Professor William McPherson, son, Ohio State University. *Mechan-*



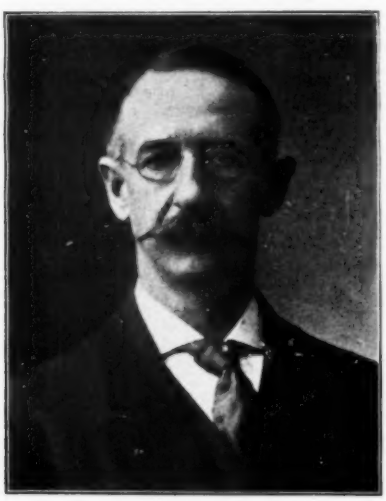
DR. HERBERT MAULE RICHARDS.
Professor of Botany in Barnard College, Columbia University, and Vice-president for the Section of Botany.



DR. WILLIAM H. HOWELL.
Professor of Physiology in the Johns Hopkins University and Vice-president for the Section of Physiology and Experimental Medicine.

DR. R. S. WOODWORTH,
Adjunct Professor of Psychology in Columbia University and Vice-president of the Section of Anthropology and Psychology.

ical Science and Engineering—Dr. J. F. Hayford, U. S. Coast and Geodetic Survey. *Geology and Geography*—Dr. R. W. Brock, director of the Canadian Geological Survey. *Zoology*—Professor William E. Ritter, University of California. *Botany*—Professor D. P. Penhallow, McGill University. *Anthropology and Psychology*—Dr. William H. Holmes, Bureau of American Ethnology. *Social and Economic Science*—President Carroll D. Wright, Clark College. *Physiology and Experimental Medicine*—Professor Charles S. Minot, Harvard Medical School. *Education*—Dr. J. E. Russell, dean of Teachers College, Columbia University.



GEORGE F. SWAIN,
Professor of Civil Engineering in the Massachusetts Institute of Technology and Vice-president for the Section of Mechanical Science and Engineering.

THE REPORT OF THE SECRETARY OF AGRICULTURE

SECRETARY WILSON'S annual report to the president is a striking document, almost bewildering in the range and magnitude of the subjects of which it treats. It is not easy to think in billions of dollars and realize what it means to say that the value of our farm products in 1908 was $7,770,000,000. This is about three hundred million dollars above the value in 1907 and three billion dollars above the value in 1899. The increase is, however, in part due to higher prices, as well as to larger production, and in so far as all prices have risen, even the farmers do not profit. But their wealth has increased greatly in recent years. The six million farms of the country are valued with their buildings and stock at twenty-eight billion dollars. While individual bank deposits have increased 12 per cent. in New York State, they have increased 285 per cent. in Iowa and 334 per cent. in Kansas. The farms of Kansas, mortgaged to the east twelve years ago, now send their profits to be invested in New York. The exports of agricultural products last year were valued at over one billion dollars, representing a great increase in the wealth of the country, though it is to be feared that it in part means the sale of the fertility of the soil. Indian corn is valued at about one third of all farm crops;

wheat, hay and cotton at more than one third and the smaller crops at nearly one third. The annual value of animal products is approximating three billion dollars.

The work of the Department of Agriculture is commensurate with this vast production of the farms. When Secretary Wilson assumed charge eleven years ago, there were less than 2,500 persons employed. There are now more than 10,000, and of these more than 2,600 may be classified as scientific men. The bureau that has had the most remarkable growth is the Forest Service, which has increased from 14 persons to 3,753. It administers an area of national forests amounting to 168,000,000 acres, which paid last year into the national treasury $1,800,000 in receipts. The income of the agricultural colleges was five million dollars in 1897 and fifteen million dollars in 1908. There was one agricultural high school in the former year and no normal school taught agriculture. There are now fifty-five agricultural high schools and one hundred and fifteen normal schools at which agriculture is taught. The Department of Agriculture distributed last year nearly seventeen million publications. The more these are read the better it is, not only for the farmers of the country, but for all the people.

SCIENTIFIC ITEMS

WE record with regret the deaths of George Washington Hough, professor of astronomy at Northwestern University and director of the Dearborn Observatory, and of Thomas Gray, professor of engineering at the Rose Polytechnic Institute.

PRESIDING officers of societies meeting at Baltimore were elected as follows: The American Society of Naturalists, Professor T. H. Morgan, of Columbia University; The Geological Society of America, Mr. G. K. Gilbert, of the U. S. Geological Survey, for the second time, he having held this office in 1892; The American Chemical Society, Dr. W. R. Whitney, director of the Research Laboratories of the General Electric Company, at Schenectady; The American Zoological Society, Professor Herbert E. Jennings, of the Johns Hopkins University; The American Anthropological Association, Dr. W. H. Holmes, chief of the Bureau of American Ethnology; The American Psychological Association, Professor Charles H. Judd, professor of psychology at Yale University and director-elect of the School of Education in the University of Chicago; The American Philosophical Association, Professor J. G. Hibben, of Princeton University.

PROFESSOR T. C. CHAMBERLIN, after presiding at the Baltimore meeting of the American Association, left for San Francisco on his way to China, where he will study the geology of the country with special reference to its influence on social and educational conditions, as a member of a commission sent by the University of Chicago.